

THE EDUCATION BLOCKCHAIN INITIATIVE

Final Report





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Pilot participants and EBI supporting organizations

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Elon University	Nebraska Supreme Court	Western Governors University
ETS	New America	Whiteboard Advisors
Evernym	North Central Texas College	
Fluree	Presidents Forum	
Georgia Institute of Technology	RANDA Solutions	
GreenLight Credentials	Southern New Hampshire	
IATC	University	
IdRamp	Stanford University	
IMS Global	Student 1	
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JetBlue Technology Ventures	Texas A&M University-	
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FOREWORD

Gayatri Agnew, Susan M. Bearden, Todd Borland, Rich DeMillo, Amber Garrison Duncan, Kara Freeman, Kerri Lemoie, Joe May, John Mitchell, Sean Murphy, Rodney Parks, Bonny Simi, Tomicah Tillemann, Harold Tran, and Connie Yowell

We started the Education Blockchain Initiative nearly two years ago during a time of significant disconnect between education and employment. Amid record-low unemployment, a tight labor market meant that our nation's employers struggled to find the talent they needed. But recent graduates lacked the skills employers coveted, continued to be underemployed, and questioned the value of their education. The mismatch between a marketplace of nearly 1 million unique postsecondary credentials and the demand for talent was stark, and it particularly impacted learners who have been most underserved.

This work was founded on the basic premise that giving learners access to and control over their educational records could help address the issue of inequitable access to economic opportunity. Empowering learners in this way makes it easier for them to share their knowledge, skills, and work experience with employers and educational providers, opening up avenues for them to start or further their careers and pursue economic mobility. In other words, the Education Blockchain Initiative sought to connect education and the workforce by helping learners translate what they have already learned and know how to do into economic benefit.

Blockchain and other distributed ledger technologies (DLTs) have significant potential to address this challenge. Research conducted through this initiative identified at least [71 active blockchain projects](#), most of which are related to credentialing. These efforts seek to ensure that individuals have permanent access to and control over their learning records.

Two years later and more than 18 months into an unprecedented pandemic that has turned the world—including our institutions of higher education—upside down, the economic conditions in which we launched this initiative have significantly changed, but the disconnect between education and employment has only grown. Over 75 percent of the jobs lost during the pandemic [have returned](#), but two in five workers who are currently unemployed have not worked in at least six months as jobs sit vacant in industries that have more openings than qualified workers. And even as the economy rebounds, Black and Latino workers continue to have [much higher unemployment rates](#) than the overall population.

Our economy adjusted to mass unemployment by accelerating the future of work, fundamentally changing which skills are in the highest demand and pushing workers to reskill and become lifelong learners. At the same time, cracks emerged within institutions of higher education that underscored why we need to give students agency and control over their learning and educational records. Roughly 6.6 million learners currently have [“stranded credits,”](#) or outstanding debt to their institutions, that impact their ability to graduate or access their transcripts.

New emergency aid programs have demonstrated the power of helping learners access their records and prior learning. For instance, at least 11 Historically Black Colleges and Universities (HBCUs) [have cleared student debts](#) in the past several months. That decision may be particularly impactful at HBCUs because Black students tend to have higher student loan balances than White students, so their economic futures heavily depend on whether or not they graduate.

The pandemic also shed light on inequities when institutions suddenly shifted to remote learning. Some learners thrived in a fully remote setting, including some learners with disabilities and some parent learners for whom courses were more accessible or a better fit for their schedules. But for learners without reliable internet, quiet spaces to study, or access to technology, it was simply unworkable, and our education and employment systems need to do better at bridging the gap.

Through the Blockchain Innovation Challenge, we have tested the potential of several innovations to empower learners and promote equity in this new economy. Our applicants collectively serve over 1.5 million learners and proposed using nearly a dozen different DLTs to inspire and equip learners.

Despite the promise of these technologies, there is still much to learn, and the need to scale proven innovations is immense. The issues driving this project will only grow as the world of work continues to evolve. We must all work together to maximize learners' ability to control their individual records and dictate their education and workforce futures in an age of lifelong learning.

INTRODUCTION

Funded by the U.S. Department of Education and managed by the American Council on Education (ACE), this report summarizes the objectives of the Education Blockchain Initiative (EBI), the objectives and key results of the Blockchain Innovation Challenge (BIC), and the work done by the selected four pilots.

In addition, this report provides a valuable summary of the EBI efforts by documenting lessons learned and best practices identified by the four pilots and informing education practitioners, workforce developers, policymakers, technology developers, and philanthropies of the potential of ecosystems centered around the premise that learner and employment records, blockchains, and interoperability standards must empower learners to generate social and economic equity.

Detailed reports for each of the pilots are available in the appendices. The top publications and resources include:

- *Connected Impact: Unlocking Education and Workforce Opportunity Through Blockchain*
- *Connecting the Pieces: The Benefits of Blockchain for Higher Education*
- “Learner Records: If You Build it, Will They Use It?”
- *What Is Blockchain?* (video)

EXECUTIVE SUMMARY

Background and Opportunity

The Education Blockchain Initiative (EBI) officially launched in February 2020 with the formation of the Steering Committee comprising subject matter experts across the K–12, postsecondary education, technology, and corporate sectors, with two key objectives: (1) generate awareness about the initiative among education and workforce practitioners and (2) support the development of a community that will sustain beyond the funding timeline. The deeper focus exploring how blockchains can be utilized to empower learners with greater control of their education identities to generate increased social equity and economic mobility was geared toward traditionally underserved and disadvantaged populations.

When this important work began, the COVID-19 pandemic, let alone its severe impact on students, educators, and employers, could not have been imagined. While it will take years to determine the true impact of the COVID-19 pandemic on achievement and equity gaps, early data suggests the impact was significant and potentially long-lasting. Typically, during economic downturns community colleges see an increase in enrollment; for example, during the Great Recession there was a nearly 16 percent increase in undergraduate enrollment, with two-year colleges seeing an almost 33 percent increase. However, according to preliminary figures from the National Student Clearinghouse, over 1,000 community colleges saw enrollment decrease by nearly 10 percent due to COVID-19. This decrease is even more alarming when we consider that enrollment of Black students dropped by 19 percent, and there was a 16 percent decrease for Hispanic students.

The troubling enrollment trends combined with sluggish job recovery rates for minorities have highlighted the need for new solutions to be explored, discovered, replicated, and scaled. It is fully acknowledged that no one solution can cure the opportunity gaps and social equity gaps that continue to ail our nation. However, innovations like blockchains, learning and employment records (LERs), and an ecosystem-first approach to implementing them can be one of the many bridges needed to cross these inequitable chasms.

Objectives

From the onset of the EBI, the appeal for technology-enabled solutions that reoriented the education and employment ecosystem around the individuals they aim to serve focused on three key goals and themes:

- Empower all learners: How can learners exercise agency over their digital identities, including all records of learning, so they can share them in a secure, validated, and machine-readable way?

- Unlock lifelong learning: How can learning be better documented, validated, and shared no matter where it occurs? How can control of ownership of learning records improve the way underserved learners connect with and unlock disparate learning opportunities?
- Improve economic mobility: How can blockchain help learners to find on-demand education in employment-relevant skills to advance economic mobility and to fulfill the promise of higher education?

The Blockchain Innovation Challenge

To deliver on these goals, the project implemented a Blockchain Innovation Challenge (BIC). Through the BIC, ACE convened a series of webinars for interested stakeholders to gain a better understanding of blockchains, LERs, and their potential through action learning with experts from the field. ACE also created a focused group within the ACE Engage® environment to expand the community of interest, ideate and share ecosystem models, and to activate networking across K–12, postsecondary institutions, employers, and technology providers.

The BIC required proposals to follow the [application guidelines](#) centered on three criteria: 1) the quality of the ecosystem-first design approach, 2) the quality of the technological approach, and 3) the quality of the management plan and adequacy of resources. The interest generated by the BIC exceeded all expectations, demonstrated by the fact that institutions of higher education that submitted applications or were part of a proposal currently serve over 1.5 million students across the country. The applications received were of very high quality, making the selection process rigorous and challenging to select only four Phase 1 winners:

- **Pilot A: Guardianship & Consent for Nebraska Systems-Involved Students** is a collaboration between Student1, the Nebraska Department of Education, and Nebraska Department of Health and Human Services to replace a current manual paper process for guardians of systems-involved students to provide legal and verifiable consent for services for their minor child and associated data sharing required to effectively provide those services. This initiative sets the foundation for a comprehensive learner record for Nebraska K–12 students who are involved with multiple state educational, judicial, or behavioral services.
- **Pilot B: The Lifelong Learner Project, Powered by Teachers**, is an ecosystem-first approach led by RANDA Solutions, in partnership with the Utah Department of Education and others, to develop a digital wallet in which teachers can store and access their credentials, licenses, and exemplars of practice and securely share them with entities such as state licensing systems, human resource departments, and learning management systems.
- **Pilot C: The UnBlockEd Project: Leveraging Blockchain in Higher Education** is an effort led by the University of Arizona, in partnership with Georgia Institute of Technology, Fluree, and the John N. Gardner Institute for Excellence in Undergraduate Education, to create an open transfer exchange system that will facilitate student progress toward graduation by making the transfer articulation process more transparent.

- **Pilot D: North Texas Collaborative** is a Texas Woman’s University-led collaboration with Carrollton-Farmers Branch Independent School District, North Central Texas College, Texas A&M University-Commerce, The University of Texas at Arlington, and GreenLight Credentials to narrow the college graduation and employment gap of underserved populations by increasing students’ free access and control of their academic records.

When the four Phase 1 pilots all met their minimum viable product (MVP) deliverables, they were selected by the EBI Steering Committee for Phase 2 advancement. Considering the endurance of the COVID-19 pandemic and its impact on educators and employers, the amount of work achieved by the pilots in a little over eight months was impressive and encouraging.

Scaling Impact

Blockchains in the education and employment sectors are still new; the BIC pilots and those who have embraced its usage to this point are pioneering this new innovation. These trailblazers are paving the way for wider adoption of blockchains. The foundation of a great community has been formed, and these pilots (and others) have identified some important lessons learned and best practices that will help those looking to replicate and scale similar applications of blockchains and LERs.

It is imperative that implementation of blockchains and LERs do not succumb to the same pitfalls of past innovations that held the promise to generate the equity and opportunity for all populations our nation sorely needs. The ecosystem-first approach centered around learner empowerment and social equity can allow blockchains and LERs to deliver on their promise.

It is strongly recommended that these early adopters of blockchains and LERs create inclusive ecosystems and design applications and systems with the goal to generate economic mobility, social equity, student empowerment, and lifelong learning opportunities.

EDUCATION BLOCKCHAIN INITIATIVE OVERVIEW

When the American Council on Education (ACE) formally announced the project funding from the U.S. Department of Education, the Education Blockchain Initiative (EBI) was designed to explore how blockchains can improve the flow of data in the education and workforce ecosystems, while empowering individuals with control of their educational outcomes in order to generate economic opportunity.

This project benchmarked efforts by the Department of Education to explore how different applications of blockchains can facilitate student control of their learning records, regardless of where the learning occurred. As the federal government and employers continue to embrace skills-based hiring practices, there must be new ways for individuals to record and signal their skills and achievements.

Lines separating the twenty-first-century education and workforce ecosystems are becoming increasingly blurred. Where learning occurs, how skills are gained, and where achievements are earned are no longer siloed. To usher in the skills economy, it's essential to ensure that learning, skills, and achievements are signaled by individuals to prospective employers and institutions of higher education. This must be done quickly, securely, and free of bias, and the EBI endeavored to see what role blockchains may play in supporting this new way of recording and sharing. The EBI was broken down into two major workstreams, with research first and the pilot challenge second.

EBI Workstream 1 (October 2019–July 2020)

The EBI began with the development of the research paper *Connected Impact: Unlocking Education and Workforce Opportunity Through Blockchain*, published in June 2020. The author of this report interviewed leaders across the education, credentialing, and technology spectrum and identified over 70 active blockchain initiatives. While a chief purpose of this report was to aggregate ongoing efforts in order to inform the community of the exciting and innovative work taking place, another important aspect was to use this new information to inform the design of the Blockchain Innovation Challenge (BIC).

In tandem with this research and discovery, supplemental materials were also developed. First, the educational video *What Is Blockchain?* was produced to serve as an informational foundation for all stakeholders. Second, an introductory report, *Connecting the Pieces: The Benefits of Blockchain for Higher Education*, was written to provide a broader introduction to inform the basics of blockchain. Both the video and the paper continue to provide sustained value across stakeholders.

EBI Workstream 2 (February 2020–October 2021)

Workstream two of the EBI implemented the BIC. The BIC included a \$900,000 competition designed to encourage new and creative approaches to harness the potential of blockchains to help empower learners with a special emphasis on generating economic mobility for underserved learners.

Early in the design work, it was determined that interoperability should be a priority component of the BIC as part of the criteria for the pilot funding. The Department of Education was so invested in the importance of interoperability as blockchains and LERs are developed that they commissioned a white paper. In July 2020, *Understanding Interoperability for Education Blockchains* was published. The paper demonstrates how verifiable credentials (VCs), decentralized identifiers (DIDs), and LERs can deliver interoperability.

To catalyze interest in the BIC and ensure enough high-quality applications were received, community building was essential. Planned with the original contract were in-person events to increase interest in the initiative, educate the community about blockchains and LERs, and provide interested parties with an opportunity to connect and engage with each other. Unfortunately, due to COVID-19, in-person informational and informal “match making” events had to pivot to a virtual environment. The ACE Engage platform served as the primary tool in connection with the Department of Education’s GitHub.

Through Engage, a series of networking events and informational webinars were conducted. Through this collaboration and networking environment, a secured blockchain innovation group was established, expanding the capacity to store these webinars and provide links to important resources for those developing their BIC proposals. The Engage group also afforded its 100-plus members the opportunity to communicate with each other and create videos sharing their vision for their blockchain pilot. Despite having to use these unconventional means, their effect yielded positive outcomes beyond expectations.

On August 12, 2020, the EBI launched the early release for BIC applications and details of the application guidelines. Given the uncertainty the COVID-19 pandemic presented to all stakeholders building pilots, the application window was extended to October 30, 2020 for submissions.

The application guidelines provided interested parties with the general framework of what proposals should include and consider as they thought creatively about their own blockchain solution. Three themes were reinforced as stated in the executive summary of this report:

- Empower all learners
- Unlock lifelong learning
- Improve economic mobility

Based on the research from the *Connected Impact* report, it was important to test potential best practices for ecosystem-first design approaches. To help guide applicants as they created new ecosystems and partnerships, these were the three key opportunity areas:

- **Building community and consensus:** Networks of institutions and organizations are important precursors to many blockchain initiatives in education. It's essential to cultivate these communities to solve a common challenge and engineer a blockchain solution as the connective tissue to pull existing components of the ecosystem together and reorient them around the needs of learners.
- **Interoperability and open design:** Solutions that leverage interoperability, open data standards, and protocols are critical to the mobility of individuals between the multiple learning and employment domains in their lifetime.
- **Data literacy and agency:** While blockchains hold the potential to provide individuals with greater control over their education and employment achievements and greater pathways to jobs and education opportunities, we must counter the digital skills and data literacy divide. If this is not addressed in the design, then blockchains, and other exciting innovations, have the potential to compound existing disparities for our traditionally underserved populations.

Upon launch of the BIC, it was exciting to see the community respond. Higher education institutions and other organizations with zero experience in blockchain identified its potential and interacted with the community through Engage and other platforms. Partnerships that otherwise would not have occurred were formed through Engage and Zoom networking events. Attendance with webinars was consistent and many applicants conveyed their appreciation for these events, which helped them gain a better understanding of how blockchains work and their importance for the interoperability of LERs.

The community's response to the BIC was evident with the number of proposals received. To highlight the interest generated by the BIC, a "Meet the Applicants" summary was compiled.

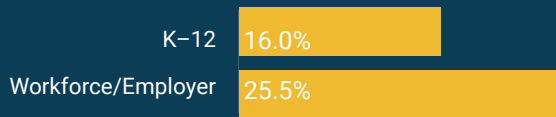
MEET THE APPLICANTS

AN ECOSYSTEM-FIRST APPROACH

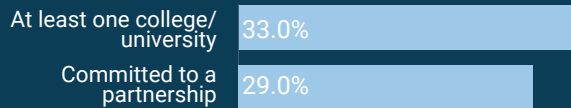


Participants averaged four partners per ecosystem

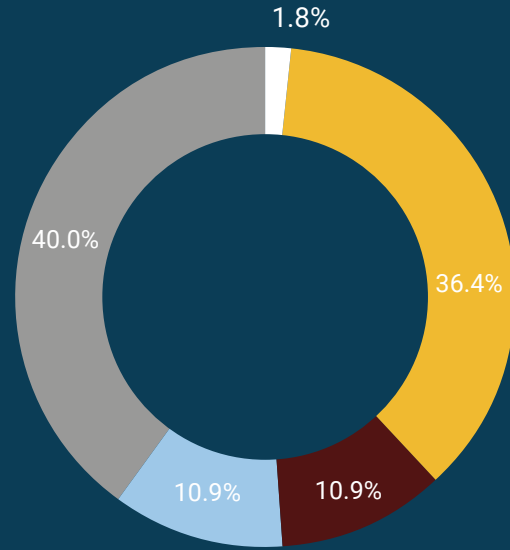
Top partnerships of higher education institution applicants



Percentage of partnerships in non-higher education institution applicants



MAIN APPLICANT ORGANIZATION TYPE



● Accreditor ● College/University ● Nonprofit Organization
● State/City/County ● Technology Firm

PERCENTAGE OF APPLICANTS USING NEW OR ESTABLISHED SOLUTIONS



● Proposed creating new solutions ● Proposed using established vendors

BIC APPLICANTS SERVE OVER 1.5 MILLION HIGHER EDUCATION STUDENTS ACROSS THE COUNTRY



● 4-Year Institutions ● 2-Year Institutions ● Online ● Historically Black Colleges and Universities

THE BIC EVALUATIVE CRITERIA AND SELECTION

To prepare potential applicants for this challenge, a robust evaluation and selection process was designed with a published set of guidelines. Fidelity of implementation, rater training, and rubric development was facilitated by ACE's research division.

The process included the following steps:

- Each application was prescreened to determine if it met the basic application guidelines and warranted being reviewed for pilot consideration.
- Each application was prescreened for its technology approach to ensure it met the parameters set forth in application guidelines.
- Applications that cleared these two prescreening processes were then reviewed by four independent evaluators. The team of evaluators was trained by ACE and the Presidents Forum on how to use the in-depth evaluation rubric when reviewing proposals.
- Each application was reviewed by two randomly assigned evaluators and the scores were then averaged. Protocols were established to solve for scoring discrepancies.
- The top 15 percent of all applications scored were advanced to the BIC Steering Committee for funding consideration.
- The Steering Committee was divided into two groups: the assessment group and the selection group.
- The assessment group reviewed each of the pilot finalists and provided a scorecard ranking.
- The selection group reviewed each application, considered the scores and rankings of the assessment group, and then selected the four BIC winners.

To ensure the integrity of the evaluation process, Steering Committee members disclosed any conflicts of interest, or potential conflicts of interest, among the finalists. If a Steering Committee member disclosed a conflict of interest, their scores, rankings, or votes **did not** count toward the eventual selection of the BIC winners.

In December 2020, the four pilots selected for Phase 1 of BIC funding included:

- **Pilot A: Guardianship & Consent for Nebraska Systems-Involved Students**
- **Pilot B: The Lifelong Learner Project, Powered by Teachers**
- **Pilot C: The UnBlockEd Project: Leveraging Blockchain in Higher Education**
- **Pilot D: North Texas Collaborative**

The rigorous selection process yielded diversity of blockchain approaches. Pilot A endeavored to create new, and critically needed, verifiable credentials like guardianship and consent. Pilot B sought to create a new wallet custom designed for a specific field of employment. Pilot C directly tackled the challenges presented to transfer students and empowering learners with knowledge to make better-informed decisions. Pilot D created an ecosystem replicating and scaling the innovative work that took place at Dallas College not long before the launch of the BIC.

EXECUTING THE PILOTS

The available funds for the pilot prizes totaled \$900,000, and this was distributed in two phases:

1. Phase 1—Developing a Minimum Viable Product (MVP) (January 14–April 30, 2021)
2. Phase 2—Building and Expanding (May 15–September 30, 2021)

Phase 1 winners were each awarded \$150,000. All four Phase 1 pilots demonstrated interoperability of their MVP and were advanced to Phase 2 and received a balance of \$75,000 for full implementation of their pilot.

BIC Phase 1—Developing a Minimum Viable Product (MVP)

On January 14, 2021, the four winning pilots were convened to officially launch their projects and to develop their minimum viable products (MVPs). The Presidents Forum worked with each pilot site to establish the objectives and deliverables that were unique to each project. The Steering Committee then reviewed and provided input on the proposed MVPs before they were finalized.

Throughout this phase each pilot site had regular meetings with its ecosystem partners and the Presidents Forum. At the end of this phase a live demonstration was held for the pilots to present their MVPs to the Steering Committee. These presentations also afforded the Steering Committee an opportunity to engage directly with the pilots, ask questions, and share advice before determining which pilots would advance to the next phase. In order to advance to the second round of the BIC and receive additional funding each pilot site had to demonstrate its MVP objectives. The Steering Committee determined that each pilot met its individualized MVP deliverables and all received funding to advance to Phase 2.

BIC Phase 2—Building and Expanding

The pilots used this phase to build upon their MVPs. Some also began to expand their ecosystems and cultivated critical lessons learned for sharing with the broader BIC community.

Interestingly, each pilot established new goals because of the additional BIC funding. With the technology aspect of their pilot mostly developed by this point, many shifted their focus toward their education and user recruitment plans. They also began to set goals and objectives to generate social equity, economic mobility, and learner empowerment in the near and long term.

The commitment and integrity of the work these pilots achieved during these nine months is inspiring. There is an expectation and a desire that the community can leverage the lessons learned and best practices identified by the pilots to build upon and expand their work in the months and years to come.

To learn more about each pilot, their overviews are below. For a deeper dive into each pilot's achievements and lessons learned during Phases 1 and 2 please read their reports, which can be found in the appendices.

SYNOPSIS PILOT A: GUARDIANSHIP & CONSENT FOR NEBRASKA SYSTEMS-INVOLVED STUDENTS

Overview

The project Guardianship & Consent for Nebraska Systems-Involved Students addresses a critical need to replace a current manual paper process for guardians to provide legal and verifiable consent for services for their minor child and the associated data sharing required to effectively provide those services. Systems-involved students are those involved with multiple educational, judicial, or behavioral systems in different agencies.

The project partitioned the problem into two areas, addressed over two phases:

1. Apply self-sovereign identity (SSI) and verifiable credentials (VCs) to express the legal guardianship of a minor.
2. Building upon the foundation of verifiable guardianship, apply VCs to guardian's consent.

Partners

The partners are Student1, the Nebraska Department of Education, and the Nebraska Department of Health and Human Services.

About the Project

In order to allow guardians to issue legal and verifiable consent for services, the project addresses two major objectives:

1. Manage student guardianship, with all its nuances, in a manner that is decentralized, legal, and verifiable.
2. Enable verifiable parent/guardian consent for high-stakes, cross-agency services, and participations, such as receiving mental health therapy.

While they are focused on the needs for systems-involved students, the work is meant have a broader impact across K-12 and early childhood.

In Phase 1, the project defined a draft Minor Guardianship Verifiable Credential (VC) whose intent is to exactly match the legal designation of guardianship across a spectrum of use cases. The effort researched guardianship laws in Nebraska and similar laws in a sample of other states. A VC schema and associated Trust Framework was developed with the expectation of it being the first draft for an industry standard.

The issuance of a Guardian Identity VC and a Guardianship VC into a guardian wallet was demonstrated based upon a notary model, where these credentials could be issued by the Department of Education as part of school registration processes. The demonstration included the selective disclosure presentation by the guardian to a third-party service provider.

Lessons Learned

- A flagship of their work is a draft standard for a Guardianship VC and its Trust Framework. Having a lack of an acceptable standard for guardianship, approaching its development under the objective of creating a future standard urged the effort to research design and document the work in a more thoughtful manner.
- SSI and VCs are powerful concepts with many education domain applications, including our guardianship and guardian consent domain.
- The underlying technologies supporting SSI and VCs are emerging, rapidly advancing, and immature.
- The standards developments led by the W3C, and others, are similarly early in their maturity, with version 2.0 standards based upon a deeper base of experience just now becoming available in some areas.
- Early implementations (and therefore the technologies and standards) are being driven by large commercial and government business models that do not reflect unselfish self-sovereignty and interoperability interests.

SYNOPSIS PILOT B: THE LIFELONG LEARNER PROJECT, POWERED BY TEACHERS

Overview

This ecosystem gives teachers agency and control over their verified teaching credentials, certifications, and the learning resources they collect. Ownership of their own information will allow educators to connect directly with teaching positions in classrooms or virtually. Using blockchain architecture, a digital wallet solution will ingest over 18 different data categories aligned with teacher credentialing, licensing, and exemplars of practice. API paths for each of these sources of data allow the teacher to publish from these source systems to the Teacher Wallet.

Partners

The partners are RANDA Solutions, Utah Department of Education, Digital Promise, ETS, University of Colorado Colorado Springs, BlockFrame, Evernym, Fluree, IdRamp, Velocity Network Foundation, Crocus, IMS Global, IATC, and Credential Engine.

About the Project

The Lifelong Learner Project, Powered by Teachers, provides an ecosystem-first approach to the creation of digital identity solutions. The project starts with educators because they are the most important leaders; they deserve to have access to the data surrounding their career so they can focus on their most important mission, educating youth. This approach builds a product that has the flexibility to extend beyond teachers and provides a solution implementable across networks.

The pilot developed an iterative, ecosystem-first approach to drive inclusivity at the onset of this effort. At any intersection of this project there are at least two stakeholders with practical yet somewhat divergent approaches to the goals represented here. The participants in this ecosystem are all iterative, forward-thinking, inclusive entities that have been driving these efforts in many communities for years, and through this project now have the unique opportunity for that work to intersect rather than diverge as it has in the past. They are “developing in public” and building in real time the business rules, data constraints, and flexibilities necessary for such a project to succeed and deliver value to the community it is designed to serve, but also to serve as a

representation of inclusive, convergent, aligned approaches to build out an ecosystem. This will include weekly design, demonstration, and workgroup efforts to ensure that alignment and inclusive approach.

Through this project, individuals in the near future will have the ability and desire to receive, maintain, deliver, and verify evidence of their professional learning and represent that to consuming systems as a verifiable credential. It is recognized the core of this interoperability lies in the ability for that user to acquire and maintain, where applicable, a decentralized identity (DID) in which they can assert information about themselves securely and verifiably. Further, these assertions must not only be machine readable but human readable as well.

Lessons Learned

- **Interoperability.** A primary goal of The Lifelong Learner Project is to implement a solution that is chain agnostic. Solving this challenge requires more than just creating a flexible blockchain solution; it necessitates architecting the solution to fit many different schemas and platforms.
- **Fledgling technology.** Architecting a solution that solves the problem in a user-friendly way is challenging when the technology is nascent and evolving as quickly as blockchain. It is critical for those working in this space to be participants in moving the technology to a mature and robust phase before widespread adoption will be possible.
- **Naming conventions.** Trying to find a common vocabulary that articulates the values of the ecosystems, addresses the challenge it is attempting to solve, and is easily understood and adoptable by the end user is critical. This common vocabulary must be established in an intentional manner with consensus from stakeholders.
- **Teacher Focus Groups.** Discussion with education professionals in various stages of their career lifecycle allowed challenges to be clarified so that the Teacher Wallet solution could adequately address them.
- **Dynamic Ecosystem.** Our flexible ecosystem has continued to expand during the phases of the Blockchain Innovation Challenge with additional members joining.
- **Lifelong Learner Project Website.** Having a simple website has allowed us to share The Lifelong Learner Project message with many more individuals and a web form has allowed us to capture the interest of the community and provide regular updates.

SYNOPSIS PILOT C: THE UNBLOCKED PROJECT: LEVERAGING BLOCKCHAIN IN HIGHER EDUCATION

Overview

The UnBlockEd Project aims to create an open transfer exchange system that will facilitate student progress toward graduation by making the transfer articulation processes more transparent. The project will empower students by leveraging the agency they gain through control of their learning records via the use of blockchain.

Partners

The partners are University of Arizona, in partnership with Georgia Institute of Technology, Fluree, the John N. Gardner Institute for Excellence in Undergraduate Education, and the Kentucky Council on Postsecondary Education.

About the Project

The UnBlockEd project provides an innovative approach for addressing inequitable transfer processes and practices, issues that broadly undermine transfer articulation's promise. Transfer articulation involves students petitioning one institution to accept previously earned academic credits from one or more other institutions (e.g., when a community college student transfers to a university). Because courses and programs are constantly changing, and students commonly accumulate credits from numerous institutions, this is a highly complex problem. Indeed, students find it to be one of the most inefficient, opaque, and frustrating process in all of higher education.

UnBlockEd is an innovative approach for addressing inequitable transfer credit recognition issues that broadly undermine transfer articulation's promise. UnBlockEd empowers students by providing them with more knowledge and control over the transfer process. This will occur through the construction of a blockchain-enabled exchange that gives students earlier insights into how particular courses transfer to specific programs at target institutions. This, in turn, will incentivize institutions to more clearly articulate the requirements associated with their degree programs, as well as the credits they are willing to accept. This design will integrate a newly developed transfer articulation capability that leverages curricular analytics in order to create efficient cross-institutional degree plans.

UnBlockEd's infrastructure will be designed to connect and interoperate with emerging blockchain-based systems that allow students to directly share coalesced academic transcripts. Thus, this system, for the first time, will yield an end-to-end system for transfer credit recognition in higher education containing an open transfer exchange that will dramatically improve the efficiency of the transfer process.

Lessons Learned

- Important academic institutional data related to degree requirements is often “siloeD” within difficult-to-access data systems. This makes it very difficult to integrate with not only a cutting-edge blockchain-enabled solution, but *any* programmatic and automated solution.
- Collaborative project-planning enables the ecosystem to recognize challenges early on and organize resources as needed.
- Transfer data fundamentally requires an idea of data equivalence, but some academic institutions do not maintain rich enough metadata to automatically evaluate suitable equivalences (e.g., a default option often involves accepting prior course work as elective credits, which are often very difficult to apply to degree requirements satisfaction).
- Building a diverse and inclusive ecosystem rather than one only built around technology providers and educators helps the ecosystem better address difficulties that arise.
- Even as academic institutions voice a desire for blockchain-enabled technology, they sometimes resist the intended outcome of student-owned data in the form of verifiable credentials.

SYNOPSIS PILOT D: NORTH TEXAS COLLABORATIVE

Overview

The overarching goal of the BIC North Texas (BIC-NT) initiative is to narrow the college graduation and employment gap of underserved populations in North Texas. The BIC-NT partners will approach this goal by increasing the number of students who have free access and control of their academic records. By increasing this pool, they also expect to increase the number of students who share their academic records with academic institutions and employers and receive employment that will help them achieve a better life.

Partners

BIC-NT is a Texas Woman's University-led collaboration with Carrollton-Farmers Branch Independent School District, North Central Texas College, Texas A&M University-Commerce, The University of Texas at Arlington, and GreenLight Credentials.

About the Project

In North Texas, the educational attainment, median household income, and income poverty rate gap between the population identified as White and the population identified as Black and Latino/Hispanic is notable. The educational attainment gap between these groups, for example, grows along with the years of education achieved. The North Texas Collaborative is a vital step to improving the economic mobility of underserved students and job seekers in Denton, Texas, as well as within the Dallas-Fort Worth Metroplex. The schools in this ecosystem have been focused on improving the economic mobility challenge for years. This consortium of institutions and technology partners is uniquely qualified to launch a blockchain-secured economic mobility platform to this geographic area.

The educational institutions coming together as a part of this initiative see blockchain as a potential solution to empower their students to improve economic mobility. Giving students the opportunity to control their records through GreenLight's platform opens up myriad possibilities for those records to be used to advance their educational and professional careers. The ecosystem seamlessly connects independent school districts (ISDs), community colleges, postsecondary institutions, and employers to allow users access to more opportunities.

A markedly better way of thinking about digital credentials and their contextual data is necessary to remove some of the challenges associated with economic mobility, like standardization, control, and data. Standards, such as the Comprehensive Learner Record (CLR), provide the ability for the one-dimensional academic transcripts, badges, and certifications to be transformed into multi-dimensional records through the inclusion of non-classroom achievements, military and work records, and activities such as volunteer work, apprenticeship and internship experiences, etc. The current ability for independent verification of such achievements through digitally signed assertions provides the needed trust in such documents to make them valuable.

Students can dynamically create their learner records from other types of academic records such as the traditional transcripts, open badges, certificates, certifications, recommendation letters, and evidence of projects. As standards and technologies such as W3C Verifiable Credentials, Decentralized Identifiers (DID), and Decentralized Public Key Infrastructure (DPKI) through blockchain networks such as Sovrin or Velocity become widely adopted, institutions will become issuers and verifiers of data. Learners will benefit from the ability to receive verifiable credentials from any source of lifelong learning and own it for posterity.

Lessons Learned

- Improve communication on architecture fit and full scope of project. Partners benefit from kick-off discussions to understand the IT requirements, specifically around file format to review system capabilities and plan for delivery.
- Allow for a planning period and contingencies. Partners benefit from having a planning period to schedule work and capacity, prepare for requirements, identify and assign resources, and clean up data, as well as to include assessment strategies.
- Explore alternative approaches to data delivery. Partners benefit from having IT and student records administration teams involved in providing input on solution delivery. This allows for discussions on alternative approaches to data delivery (i.e., transcripts on demand) and for more efficiency in system resource usage.
- Allow for administrative training early on. Partners benefit from engaging student records administration, career services, and advising staff in technology training related to customer usage of the technology solution.
- Piloting the service via trials and focus groups with students before deployment can help identify possible troubleshooting needs.

CONCLUSION

The EBI and BIC pilots innovated opportunities to explore different ways to enable learners to retain and obtain greater control over their digital identities, expand employment opportunities, and diversify lifelong learning pathways through distributed ledger technologies and new relationships. The challenge continues with these guiding questions:

- How can learning be better documented, validated, and shared? How can this be done regardless of when and where the learning occurred?
- How can empowering learners from underserved and disadvantaged populations with greater control or ownership of their learning records help them to identify and engage with learning and employment opportunities?

These questions are critical since not only are the demands of the twenty-first-century workplace multifaceted and ever changing, but also our nation's disadvantaged populations are facing ever-widening achievement and opportunity gaps. There is growing commitment, collaboration, and excitement about the potential of blockchains and the diversity of how they can be applied to solve some of the most critical challenges facing learners, institutions, and employers today.

As colleges, universities, K–12 school systems, employers, and technology providers continue to develop blockchain solutions, they must prioritize using LERs, VCs, and DIDs and building interoperability into their designs. While the long-term success of blockchains and other distributed ledger technologies are contingent upon a variety of factors, two resonate as the top critical elements of success:

1. Building a future-ready blockchain infrastructure. Creating an infrastructure committed to interoperability, SSI, and data alignment will ensure the durability of this innovation and its long-lasting impact on education and workforce systems.
2. Designing around the needs of end users (stakeholders). Developers of these new breakthrough technologies must ensure the end users are part of the design conversation. The solutions must be simple to use and intuitive or target users will not embrace them.

Lastly, the community at large must work to solve some of the chronic issues that have stalled the impact of other promising innovations. While blockchains can drive economic mobility and social equity if access to them is not unilateral, the positive impact will not reach those most in need. Policies must evolve, and priorities must be reoriented around the needs of underserved populations to allow these individuals to be part of the full potential of blockchains and LERs.

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APPENDIX A

Use Cases

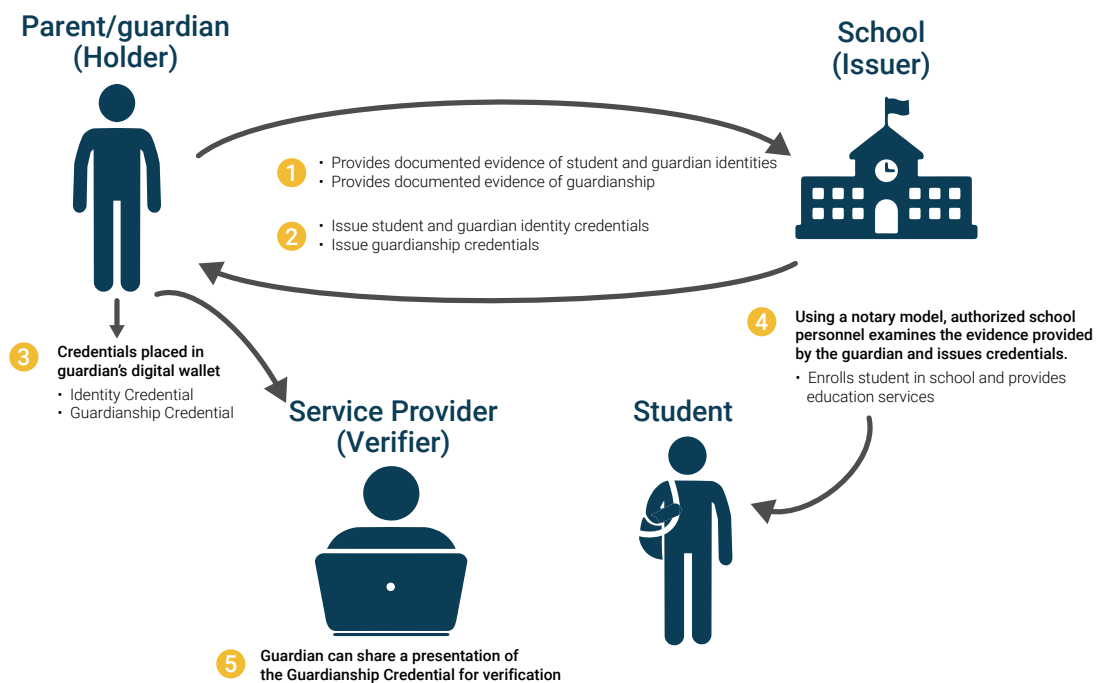


Guardianship & Consent for Nebraska Systems-Involved Students

In Phase 1, the Guardianship & Consent for Nebraska Systems-Involved Students project defined a draft Minor Guardianship Verifiable Credential (VC) whose intent is to exactly match the legal designation of guardianship across a spectrum of use cases. The project researched guardianship laws in Nebraska and similar laws in several other states. A VC schema and associated Trust Framework was developed with the expectation of it being the first draft for an industry standard.

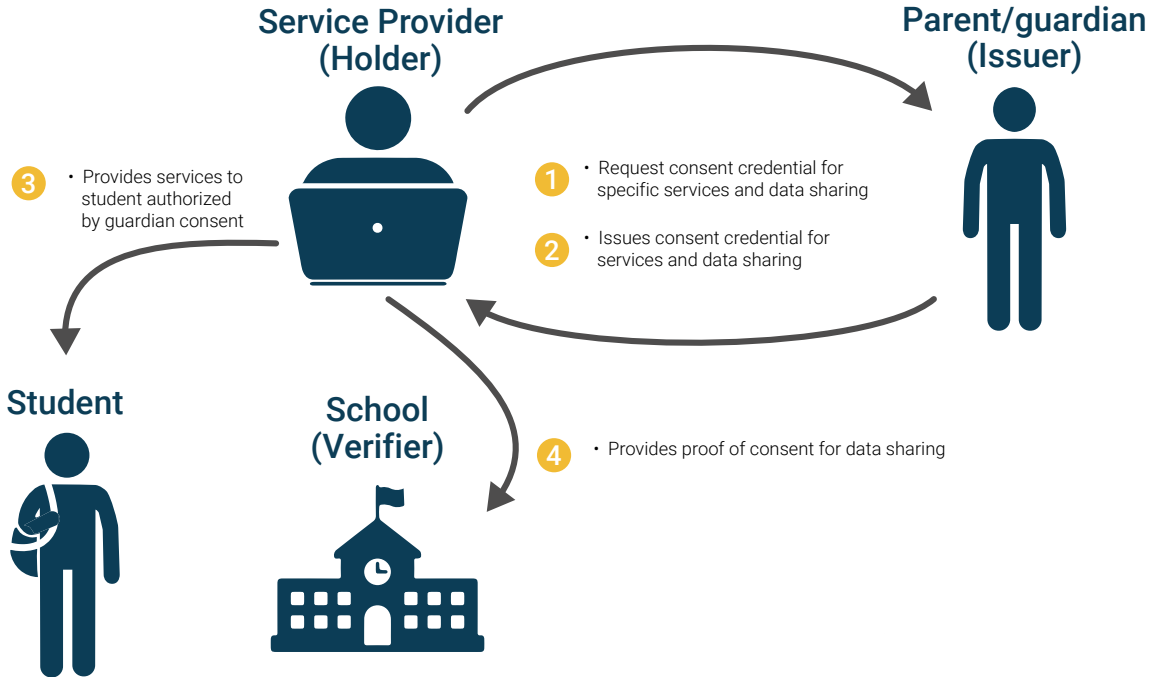
The issuance of a Guardian Identity VC and a Guardianship VC into a guardian wallet was demonstrated based upon a notary model, where these credentials could be issued by the Department of Education as part of school registration processes. The demonstration included the selective disclosure presentation by the guardian to a third-party service provider. This workflow is shown in the figure below.

Figure 1. Guardianship VC Flow



In Phase 2, a Guardian Consent VC was defined based upon a real-world example of authorizing community mental health services for a student by their guardian. Logically, the issuance of a Guardian Consent VC is accomplished by the guardian based upon a request from a service provider, as shown in the following diagram.

Figure 2. Consent VC Flow



However, current VC technologies support VC issuance by organizations, not individuals. This resulted in a technology change to demonstrate the guardian's issuance of a Consent VC.

The Lifelong Learner Project, Powered by Teachers

Louise is very excited to get to work. She has been at Acme University for four years now, with the last year being her student teaching year at Ellington Elementary, and looking forward to her own classroom and watching students grow and learn. As she gets close to graduating, there are a lot of steps for her to get to that classroom—more than she thought.

First, Louise must get an endorsement from her professor for Elementary Education at the state. The professor says this is no big deal, but first she'll need to take the ETS Praxis for Elementary Ed, which is scheduled for next week.

Louise prepares for the Praxis and does extremely well. When she is ready, she requests her Praxis results to be sent to her Teacher Wallet, and the results are transferred verifiably to her Wallet. Louise then goes to the state licensure system website, presents her proof of Praxis, and is automatically added as a license candidate to the system.

Next, Louise uses the list of EdPrep providers in the licensure system to identify she is attending Acme University. Since she has not collected a verifiable endorsement from her professor, she can generate a proof request to send to her professor. Her professor scans the QR code, which verifiably submits and endorsement to both Louise's wallet and the state system.

Finally, there are a few attestations Louise must submit. As she does so, the licensure specialist at the state can verify and mark the attestations as verifiable credentials, where Louise can easily put them in her Teacher Wallet, and her license is issued. She scans the license into her Teacher Wallet as well.

Louise is now ready to talk to HR at Ellington Elementary. When she goes in to fill out the paperwork, Mrs. Wheeler, the HR admin at the school, asks for all Louise's credentials so she can get her set up as a teacher. Mrs. Wheeler goes to the Teacher Wallet site and creates a proof request of Louise's credentials. Louise scans the proof request, submits all her credentials directly and verifiably into the HR system, and she's ready to go to work!

Typically, the above process is not so simple. Each step requires back and forth between the parties to verify and document all the information, make sure the formatting is correct and verified. This process can take three to six months to get Louise into the classroom. Through the work of The Lifelong Learner Project, it may take a week.

The UnBlockEd Project: Leveraging Blockchain in Higher Education

USER CASE 1: TRANSFER CREDIT EVALUATION

Format: As a potential transfer student, I can determine how my prior coursework will apply toward the satisfaction of degree requirements by providing my transcript and selecting a specific target academic program on the UnBlockEd platform.

Task 1.1: As a transfer student, I need to be able to supply my transcript to a four-year institution, and select a program at the four-year institution that I'd like to complete. I need to receive a completion plan that shows how my prior credits apply toward the satisfaction of degree requirements for the selected program, and the courses I need to take to complete the degree.

Result 1.1: I'll know this task is complete when I receive an optimal transfer articular roadmap, i.e., one that:

- Optimally accounts for prior coursework contained on the transcript;
- Satisfies all degree requirements associated with both the selected bachelor's degrees; and
- Has the minimum number of credit hours required to satisfy the degree requirements.

Task 1.1.a: To complete Task 1.1, prior coursework needs to be read from a student transcript extracted from a blockchain-based data store.

Result 1.1.a: I'll know this is complete when I can read a student transcript, and place the transcript data into the format required by the CurricularAnalytics.jl toolbox.

Task 1.1.b: To complete Task 1.1, data stores for degree requirements, courses, and course equivalencies need to be made available (by college/university), along with the end points for accessing them.

Result 1.1.b: I'll know this is complete when I can query these data stores through a web-based user interface and receive the correct results in JSON format.

Task 2.1.c: To complete Task 2.1, I need to be able to present the degree roadmap to college/university staff using HTML/CSS.

Result 2.1.c: I'll know this is complete when I can select a community college program and a university program from the UnblockEd.org website, and it returns results satisfying the conditions listed in Result 1 that can be rendered in a web page as an optimal two-year to four-year transfer articulation roadmap on the UnblockEd.org website.

USER CASE 2: STANDARD TRANSFER ARTICULATION ROADMAP

Format: As a community college or university staff member, I can create a two-year to four-year transfer articulation roadmap from any program at a community college to any program at a university by selecting an associate degree program from a community college and a bachelor's degree program from a university on the UnblockEd platform.

Task 2.1: As a college/university staff member, I need to access the list of associate degree programs at a particular community college, and the list of bachelor's degree programs at a particular university so that I may select one program from each, and receive a transfer articulation roadmap.

Result 2.1: I'll know this is complete when I receive an optimal transfer articulation roadmap, i.e., one that:

- Satisfies all degree requirements associated with both the selected associate and bachelor's degrees;
- All courses in the first two years of the roadmap are from the community college, and all courses in the last two years are from the university; and
- Has the minimum number of credit hours required to satisfy the requirements of both degrees.

Task 2.1.a: To complete Task 2.1, data stores for degree requirements, courses, and course equivalencies need to be made available (by college/university), along with the end points for accessing them.

Result 2.1.a: I'll know this is complete when I can query these data stores through a web-based user interface and receive the correct results in JSON format.

Task 2.1.b: To complete Task 2.1, I need to be able to submit a set of courses from a community college, and a set of degree requirements for a bachelor’s program at a university to an online service (web page that communicates with the service), and it returns a degree roadmap.

Result 2.1.b: I’ll know this is complete when the roadmap that is returned satisfies the conditions listed in Result 1 above.

Task 2.1.c: To complete Task 2.1, I need to be able to present the degree roadmap to college/university staff using HTML/CSS.

Result 2.1.c: I’ll know this is complete when I can select a community college program and a university program from the UnblockEd.org website, and it returns results satisfying the conditions listed in Result 1 that can be rendered in a web page as an optimal two-year to four-year transfer articulation roadmap on the UnblockEd.org website.

USER CASE 3: REVERSE TRANSFER ARTICULATION (FUTURE DEVELOPMENT, NOT INCLUDED IN THE MVP)

Format: As a community college or university staff member, I can evaluate reverse credit articulation from a university to a community college by evaluating a student record “against” the set of degree requirements for a particular associate degree on the UnblockEd platform in order to determine any university credits that could be reverse articulated back to the community college.

North Texas Collaborative

SCENARIO 1

Let us consider a typical transcript request scenario. A student—let’s call her Maria—is a recent high school graduate who attended a community college enrolled in dual credit courses while in high school where she received her associate of arts degree. Maria decides to transfer to a local university to complete her bachelor’s degree. Maria has applied to the university and submitted her official transcript from the community college to the university’s Admissions Office. Maria has an appointment with her academic advisor this afternoon to discuss which courses she needs to enroll in, and if there are any scholarships for which she is eligible.

When Maria arrives to campus to meet with her academic advisor, she is informed that the transcript has not been received by the Admissions Office. Maria can request that the community college send the university another official transcript, but it will take two to three days for it to be received. Maria remembers that her community college gave her access to an online transcript locker, which allows her to send official transcripts electronically at any time and at no cost to her. Maria’s high school and previous community college integrated the GreenLight platform to their student services.

Maria logged into GreenLight and shared her official college transcript with the academic advisor, who immediately received it through their email account. The academic advisor was able to download and review Maria's official college transcript to determine which classes she needed to enroll in to complete her bachelor's degree. During their advising session, the academic advisor recommended that Maria apply for some scholarships that she was eligible for based on her ranking in high school as well as her college grade point average (GPA). Maria was able to share her official high school and college transcripts with the scholarship committees using GreenLight Locker.

SCENARIO 2

A student—let's call him Daniel—is a high school senior who has been attending a community college while in high school. He is the oldest of four children to a single mom, and money is tight for this family. Daniel is a straight-A student and is in the top 10 percent of his graduating class. He would like to attend a university to get his bachelor's degree in nursing so he can help support his family. Daniel attended a college fair and visited with several universities that offer his intended major and seem to be a good fit. Daniel met with his high school counselor to discuss applying to universities and for scholarships. He was hesitant to pursue his dreams because of his family's financial limitations. Daniel would not be able to afford to pay for his college transcript to be sent to multiple universities. Daniel's high school counselor reminded him that the high school and community college utilize GreenLight, which allows students to share their official transcript electronically for free. Daniel was able to apply to multiple universities and share his official high school and college transcripts electronically at no charge. He also applied for many scholarships that would require official transcripts at no cost to him. Daniel estimates that the opportunity to own and distribute his credentials has saved him around \$200.

This access to GreenLight allowed Daniel to apply to multiple schools, which gave him options when it came to selecting a university. He was able to see which school offered the most financial aid and scholarships to help him achieve his educational goals. Without access to GreenLight, Daniel would have to submit a transcript request online that could take three to five days to be processed and would cost \$10 per transcript requested. Daniel is also planning to use his credential locker to apply to a part-time job off campus and to request an internship opportunity in the health sector that will allow him to start building his résumé.

The Education Blockchain Initiative: Final Report

APPENDIX B

Guardianship & Consent for Nebraska
Systems-Involved Students



Student1

Overview of the Project

The project Guardianship & Consent for Nebraska Systems-Involved Students addresses a critical need to replace a current manual paper process for guardians to provide legal and verifiable consent for services for their minor child and the associated data sharing required to effectively provide those services. *Systems-involved students* are those involved with multiple educational, judicial, or behavioral systems in different agencies.

The project partitioned the problem into two areas, addressed over two phases:

1. Apply self-sovereign identity (SSI) and verifiable credentials (VCs) to express the legal guardianship of a minor.
2. Building upon the foundation of verifiable guardianship, apply VCs to guardian's consent.

The results of the project are as follows:

- Draft schema and supporting Trust Framework document for expressing legal guardianship of a minor as a verifiable credential. The document was the result of iterations with the project's Nebraska partners and research into the intricacies of guardianship laws in various states. The document was developed as a first draft for comment for an education industry standard for a minor guardianship VC.
- Development of an MVP for school systems to issue guardian identity and guardianship verifiable credentials based upon evidence provided by the parent/guardian. The approach can be integrated into a future state for schools' registration process.
- Development of an MVP for a guardian issuing a consent VC in response to a request from a service provider is currently underway and has not been completed as of the publishing of this report. Because the approach requires an individual to issue a VC, the project required a technology change and re-implementation.

The project found itself being more of a pioneer than anticipated. SSI and VC standards are version 1.0, still evolving as they are applied to different use cases. Supporting technologies are early in their life cycle though rapidly advancing. The project was successful with implementation of guardianship because it followed a pattern of use that had been proven and was better-supported by the technologies. Implementing the consent VC required the project to follow a path less proven and more immature.

Despite these obstacles, the project successfully broke new ground that will ultimately prove to meet the needs of the targeted use case and provide a significant contribution to the evolving blockchain education ecosystem.

Partners

This effort is led by a partnership between nonprofit and public entities. Student1—a 501(c)(3) non-profit that partners with education agencies to focus on innovative, secure, and sustainable solutions to gnarly data problems—is leading the technological design and implementation.

Student1 is joined by the Nebraska Department of Education (NDE), a long-time partner and data system collaborator. NDE has a history of successful piloting, deployment, and support for emerging data technologies.

The project is aligned to Nebraska's Fostering Connections in Education Initiative, an effort designed to improve education outcomes for students involved in the judicial and criminal justice, child welfare, and behavioral health systems. This initiative is a formal collaboration of the Nebraska Department of Education, Nebraska Supreme Court, Nebraska Department of Health and Human Services, and the Nebraska Probation Administration.

The specific pilot use case is drawn from with the Nebraska AWARE (Advancing Wellness and Resiliency in Education) Project sponsored by the Substance Abuse and Mental Health Services Administration (SAMHSA) Center for Mental Health Services (CMHS). Jointly managed by the Nebraska Department of Education and the Nebraska Department of Health and Human Services, the project is broadly characterized as bringing preventative, assessment, response, diagnosis, referral, and treatment protocols for student mental health and behavior disorders in a partnership between schools and community mental health providers. The AWARE project pilots are being executed by three demographically and culturally diverse school districts in rural "trade center" communities in concert with their community mental health providers.

With the participation of community mental health care providers, these students are now "systems-involved." This test case provides a typical pilot opportunity to address the fundamental issues with guardian consent for services and data sharing.

Objectives

To satisfy the use case for guardians to issue legal and verifiable consent for services, the project was partitioned into two phases with the following objectives:

1. Manage student guardianship, with all its nuances, in a manner that is decentralized, legal, and verifiable.
2. Enable verifiable parent/guardian consent for high-stakes, cross-agency services, and participations, such as receiving mental health therapy.

While focused on the needs for systems-involved students, the work is meant have a broader impact across K-12 and even early childhood. In the words of Matthew Blomstedt, the Nebraska Commissioner of Education, "If something can solve the needs of our systems-involved students, all Nebraska students will benefit."

By addressing guardianship, the larger goal of the effort is to enable a much broader set of VC use cases in the K-12 education ecosystem, as discussed in the next section.

Targeted Use Cases

The Blockchain Innovation Challenge is addressing opportunities to apply blockchain technologies to translate educational experiences and achievements, skills, and work experiences into verifiable credentials that can enable individuals to control their own human capital data to better advance their lifelong success. This work advances and leverages many different efforts to apply VCs starting with high school transcripts, college transcripts and degrees, licenses, and certificates.

Many current efforts are based upon use cases where an adult learner (or near adult) can manage their credentials. Casting Guardian identity and Guardianship as a VC expands the BIC objectives to include K–12 and earlier into early childhood use cases by codifying the legal responsibilities of the guardian to nurture the development of the dependent minor. Layering Guardian Consent as a VC further unlocks a myriad cross-agency service and data sharing use cases that, today, are not well-executed, or even possible.

Verifiable credentials for guardianship enable a broader set of use cases employing VCs in K–12 education with some summarized below. The use case summaries are structured into three paragraphs, as follows:

1. A definition of the problem to solve, defining the context for the use case.
2. Identification of the users or actors who are affected by the problem, identifying the consequences if the problem is left unsolved.
3. An envisioning of the future where the problem is solved and benefits to be realized.

GUARDIANS CONSENT TO EXTERNAL SERVICES

Schools often work with external agencies and service providers to provide necessary services to students not offered or available from the school. Examples include behavioral health services, mental health services, drug rehabilitation services, and special education services. These services require a parent/guardian's consent.

The current manual, paper process acquiring guardian consent is burdensome for school personnel. In addition, the logistics can be time consuming: locating and contacting the parent/guardian, scheduling a meeting time, and when meeting face-to-face, verifying guardianship, and obtaining the consent signature. This process often delays the start of needed services for the student.

By applying verifiable credentials to guardianship and guardian consent, the process is streamlined for school personnel. Guardianship credentials can be issued by the school at registration time. Guardians consent credentials, dependent on guardianship, can be issued as necessary. The parent/guardian is self-sovereign to manage their credentials in their personal wallet. In addition to relieving the burden on school personnel, the benefit is that students receive services in a timelier manner.

SCHOOL TRANSFER

When a guardian changes the school for their child, the receiving school needs the student's transcript and school records to properly place the student and assign classes. This problem is compounded for special education students where the guardian needs also to obtain the student's latest Individualized Education Program (IEP).

Today, this process can be complex for guardians to navigate and may take weeks to successfully move the student's records to the new school. The guardians must contact the original school to request transfer; the school must gather and verify the student's data; and the receiving school must receive and record the student's information into their systems.

Enabling schools to issue student transcripts and records as verifiable credentials to parents/guardians creates a simplified workflow and puts the guardian in charge of the transfer. These credentials should be issued automatically at the end of year or end of semester; guardians can also request the student's credential as required at other times. Once integrated into the school's system, the approach will streamline the process for both the guardians and the school personnel and reduce the latency in moving these credentials. Student transcript and school records held by the guardian would transition to the student once they reach 18.

LEARNING CONTINUITY FOR IN-YEAR TRANSITIONS

Students may be unexpectedly forced to transition due to involvement with judicial and criminal justice, child welfare, and behavioral health systems. Circumstances can transition the child temporarily into special or facility-based schools. Here the issue is not simply one of placement in a new school, but how to maintain learning continuity for the student. This requires access to up-to-date information on lessons and assignments, and the student's performance.

Students, in addition to navigating the complexities of these systems, must often deal with a material disruption in the continuity of their learning. Instructional personnel, operating without up-to-date information, often must take on the task of contacting the student's prior teachers and administrators to gather the data required.

By integrating with learning management, formative and summative assessment, and gradebook systems, verifiable credentials may be automatically generated as required and shared under the control of the guardians. An automated process could provide timely information the same day to ensure instructional continuity for the student. Instructional continuity across transitions is critical for the student's academic success.

COLLECTING EVIDENCE OF ACCOMPLISHMENTS

Systems-involved students historically struggle with their academics and are statistically more likely to drop out of school. Verifiable evidence of their accomplishments, large and small, such as skills mastered, work experience, badges earned, awards, extracurricular activities, special studies, or professional certifications, can be motivating for the student and improve their self-esteem.

Schools often do not officially record these types of accomplishments. Even when they do, there is no mechanism for students to collect and manage these accomplishments. Yet, without these “credentials” a true picture of the student is missing.

Schools could provide a common infrastructure to issue verifiable credentials for these accomplishments that can be exercised across a variety of situations and systems. The accomplishment credentials should be issued to both the guardian’s and student’s wallets; the guardian can share these accomplishments as necessary; and the student can be proud of the recognition for their accomplishments. The approach would be instrumental in improving the student’s school experience particularly for systems-involved students.

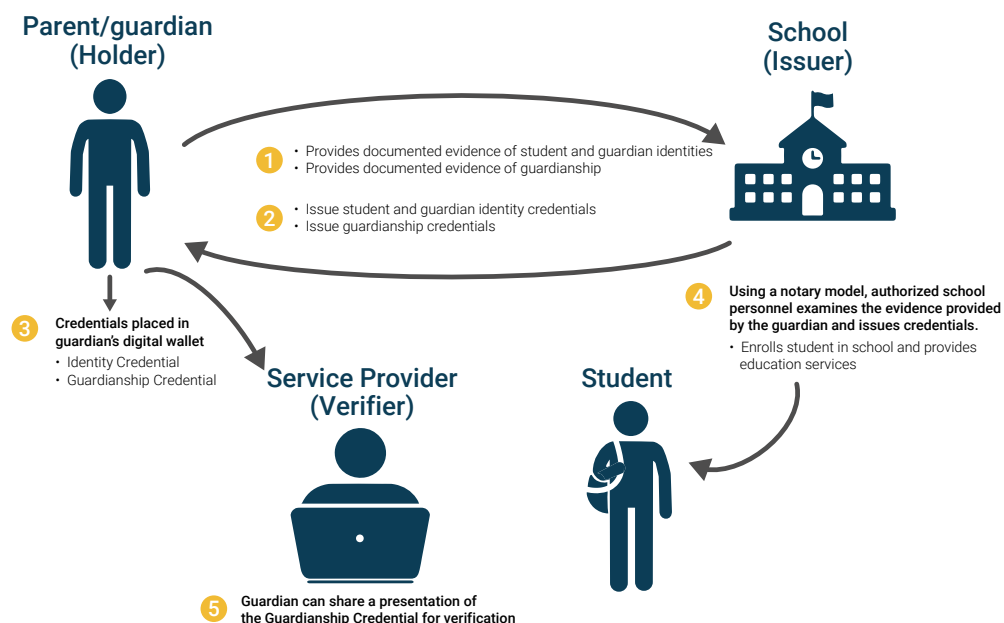
Project Process

USE CASE WORKFLOW

In Phase 1, the Guardianship & Consent for Nebraska Systems-Involved Students project defined a draft Minor Guardianship Verifiable Credential (VC) whose intent is to exactly match the legal designation of guardianship across a spectrum of use cases. The project researched guardianship laws in Nebraska and similar laws in several other states. A VC schema and associated Trust Framework was developed with the expectation of it being the first draft for an industry standard.

The issuance of a Guardian Identity VC and a Guardianship VC into a guardian wallet was demonstrated based upon a notary model,¹ where these credentials could be issued by the Department of Education as part of school registration processes. The demonstration included the selective disclosure presentation by the guardian to a third-party service provider. This workflow is shown in the figure below.

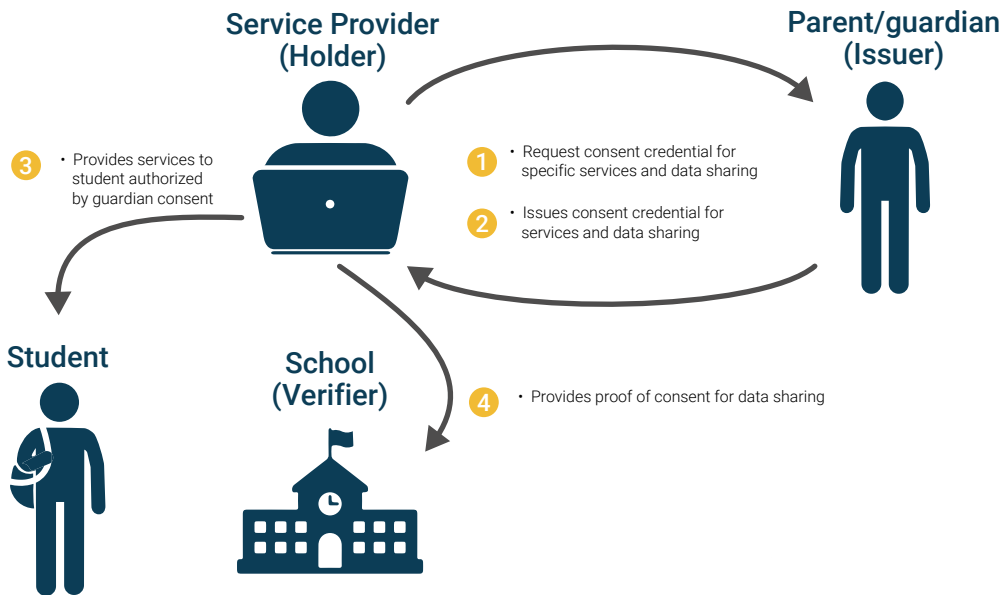
Figure 1: Guardianship VC Flow



¹ Later reflection indicates that this role is more than a notary, who verifies signatures. The use case also requires the examination of evidence to trust the claim of guardianship.

In Phase 2, a Guardian Consent VC was defined based upon a real-world example of authorizing community mental health services for a student by their guardian. Logically, the issuance of a Guardian Consent VC is accomplished by the guardian based upon a request from a service provider, as shown in the following diagram.

Figure 2: Consent VC Flow



However, current VC technologies support VC issuance by organizations, not individuals. This resulted in a technology change to demonstrate the guardian’s issuance of a Consent VC.

METHODOLOGY

The need and requirements for guardian consent originated in prior work accomplished by Student1 with the Nebraska Department of Education related to identifying opportunities for and barriers to information and data sharing between and among schools, intervention providers, and behavioral and mental health professionals. Guardian consent emerged as an area with multiple challenges and opportunities to, not only streamline a principally paper-based process, but to better inform guardians about consent and provide them with solutions to control access to information about their child.

The consideration of a blockchain solution (versus a more traditional enterprise database application) was motivated by the following:

- Consent for mental health services is “high stakes” with respect to legal, security, and privacy concerns.
- VC self-sovereignty puts the guardian in control.
 - » Does not require requests for documents to be shared.

- » Sharing can span agencies without complex agency-to-agency interfaces.
- » Agencies generally recognize the rights of the guardian, avoiding getting mired in agency policies.
- » Agencies and governments cannot track who guardians share their credentials with.
- » Data may be selectively disclosed based upon a need to know – as controlled by the guardian.
- » Workflows are simplified with the individual in charge, reducing the cost and complexity of enterprise systems.

The project was structured as two phases:

1. Develop and demonstrate issuance of guardian identity and a guardianship VC using a notary model for issuance.
2. Develop and demonstrate the issuance of a guardian consent VC by the guardian based upon a request from a service provider.

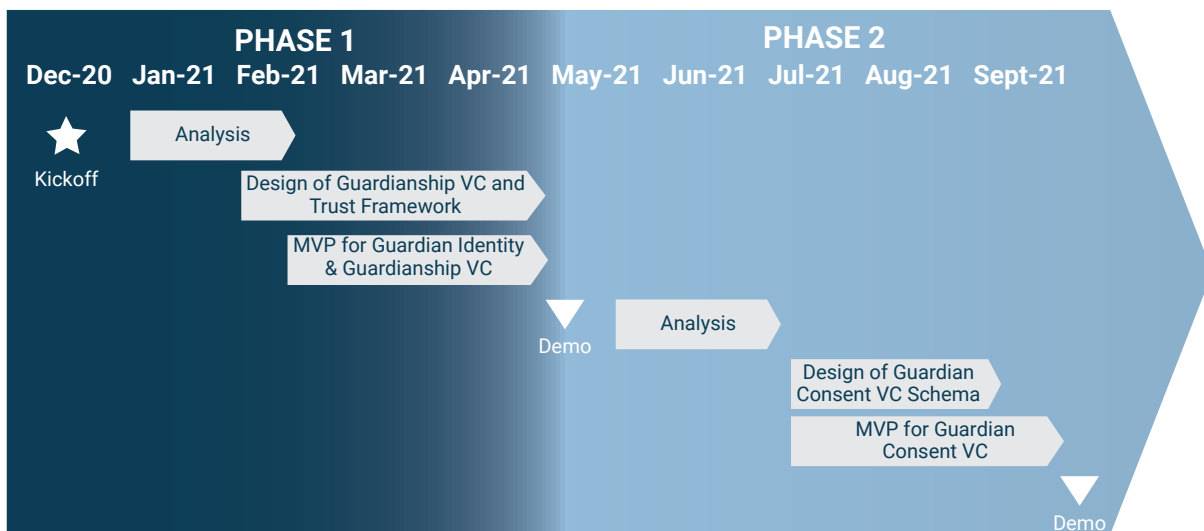
Each phase was structured into three tasks:

1. An initial analysis task specifically focused on selecting blockchain technologies that best meet the SSI and VC needs of the phase.
2. Development of a draft schema, accomplished in parallel with the next task.
3. Development of the MVP, demonstrating issuance of the VC and subsequent presentation proof.

This methodology and timeline are shown in the following figure.

Figure 3: Methodology and Timeline

Education Blockchain Initiative Timeline



From the outset of the project, the project was pioneering the application of VC technologies to this use case. The analysis tasks were precipitated by deliberate resolve in the following areas:

1. Hold steadfast to how the use case should be ideally implemented.
2. Match the technologies to the use case requirements, and not the other way around.
3. Where compromise or workaround are required, compromise in the technology selections and the MVP implementation.

Guiding principles

The following are principles that guided the project methodology:

1. Hold true to *self-sovereignty* as the fundamental principle for identity and VCs, having the following implications:
 - a. Pursue a blockchain solution that is decentralized, and not governed by a single organization.
 - b. Favor a public blockchain, and not a permissioned blockchain, that inserts unnecessary points of control.
 - c. Avoid vendors with business models that weaken self-sovereignty with vendor lock-in.
2. Reflect the legal, security, and privacy complexities of the minor guardianship consent use case, as follows:
 - a. The solution must align with pertinent laws, such as HIPPA and FERPA.
 - b. Reflect the breadth of laws governing guardianship.
 - c. Support the policies and best practices of data privacy.
 - d. Employ Zero-Knowledge Proof (ZKP) technologies that support *selective disclosure* on a need-to-know basis.
 - e. Leverage the power given to legal guardian consent to enable cross-agency, cross-discipline data sharing and collaboration.
 - f. Also factor in the emotional aspects of data privacy, for example, recognize the public's inherent distrust of large government or corporate data solutions.
3. Build upon a blockchain infrastructure appropriate for public sector application, as follows:
 - a. Low cost
 - b. Standards-based
 - c. Platform-neutral
 - d. Blockchain-neutral
 - e. Vendor-independent
 - f. Open source

4. Adopt standards and technologies for interoperability, as follows:
 - a. Standards, even those still evolving, drive interoperability
 - b. Important W3C Standards to follow include: [Verifiable Credentials](#), [JSON-LD](#), [BBS+ Signatures](#), and [Universal Wallet](#)
 - c. Select technologies who are committed to the open standards and interoperability (e.g., support multiple blockchains, interoperable wallets, etc.)
 - d. Pay attention to implementation details that may insert dependencies that deter interoperability, for example proprietary data stores, or custom services.
5. Let the use case drive the implementation, adopting the VC technologies that best serve the near and far-term needs.
 - a. Strive toward the best application of the technologies to the use case; avoid compromises for technology's sake.
 - b. Be steadfast to the desired VC workflows, as outlined above, realizing that this makes the consent VC implementation considerably more difficult to implement.

ECOSYSTEM-FIRST APPROACH

This project was based upon an *ecosystem-first* approach. As mentioned above, this project was designed to align to Nebraska's Fostering Connections in Education Initiative. By leveraging existing cross-agency partnerships and processes within an already complicated system, the problem space does not require the building of an ecosystem. This allows the project to focus on affecting change and growing adoption in existing state ecosystems supporting systems-involved students. Similar structures can be found in other states nationwide, increasing the opportunity for expanded adoption.

Getting started

The project started by building upon prior efforts analyzing use cases for the Nebraska AWARE project. This activity identified guardian consent as their highest priority automation need. The consideration of a blockchain solution was driven by:

- Guardian consent for authorizing mental health service in the context of a school is “high stakes,” requiring a legally accepted, high-security, and high-privacy solution.
- The concept of self-sovereign verifiable credentials is a good fit in an area where privacy concerns by parents and guardians is high.
- The large amount of global activity by the blockchain ecosystem pointed to an emerging technology “to ride.”

Thus, the project started with deep understanding of the problem domain, boosted by a close working relationship with subject matter experts in Nebraska. By contrast, knowledge of blockchain technology was cursory, at best.

The processes for getting started was dominated by:

- Efforts to research, understand, evaluate, and select an appropriate technology stack.
- Establishing the principles that will guide the effort (as described above).
- Rethinking the application workflow reflecting the concept of self-sovereign VCs.

It should be noted that the project specifically did not pursue an approach of selecting a more experienced blockchain vendor to develop an MVP solution, though informally interviews were held with several vendors. Not surprisingly, the sample of vendors interviewed were biased toward their own specific technology focus. Because the project explicitly wanted to match the technology stack to the problem domain, and not the other way around, the more difficult path of in-house development was taken.

Social equity

Systems-involved students are not only the most likely to require cross-agency information sharing; they are also most academically at risk. These students, throughout their lives, will interact with multiple educational, judicial, and behavioral health services provided by both governmental and non-governmental organizations.

The population includes:

- Abused, neglected, abandoned, or dependent children.
- Homeless students.
- Disconnected youth.
- Children with disabilities.
- Students with behavioral health needs.
- Children in foster, kinship, congregate care, or awaiting adoption.
- Juvenile law violators in Juvenile or Criminal Court for a traffic, status, or criminal offense (misdemeanor or felony).
- Juveniles involved with specialized truancy or drug courts, or in pre-trial diversions.
- Incarcerated youth and those on probation.

These students often have complex co-occurring needs and significant personal trauma amid multiple transitions, including transitions in residential placement, school, and legal status. There is a critical need for cooperation and to share student information across a myriad of organizations, service providers, and agencies in an environment that is mired in a complex set of laws and policies. There is also an identified need for students to have access to their comprehensive records as they transition or once they exit care.

Guardian consent is a critical tool in improving the circumstances of these students, allowing guardians to provide timely, informed, legal consent for services and information sharing across agencies, as follows:

- Guardian consent is the key to unlock cross-agency data sharing.
- Avoid students “falling through the crack” between agencies.
- Provide continuity in learning across transitions.
- Timely, coordinated, effective services addressing the needs of the “whole child.”

As such, the project is aimed at enabling the ecosystem supporting systems-involved students to collaborate and take the necessary actions to substantially impact the trajectory of these high-need students, to provide a cohesive learning environment that prepares the students for postsecondary success, and to build their portfolio of learning credentials that improve their economic success and mobility.

Solutions that meet the challenging needs of systems-involved students will be transferable to empower all learners and their guardians in the K–12 environment at large.

User education plans

Applying the concepts of SSI, VCs, and self-sovereignty requires a mind shift change from having enterprises be the center of control to one where individuals now have that control. As a result, the user education process is necessarily multi-faceted:

- Users and stakeholders at all levels must understand the technology and its implications to the extent that it is *trusted*.
- Policies and laws may need to change to enable legal adoption of the solution. This will require its own form of education and advocacy.
- Processes and backend systems will necessarily change to support the self-sovereignty paradigm. Users must be trained in these new processes and systems.
- The IT organizations in participating agencies must become familiar, be trained, and support the new blockchain technologies.

Throughout the process, the project expects to significantly evolve the user interface to make it easy for users, particularly the guardians, to use the guardians consent solution. The long-term plan is to wrap the solution in a custom guardian wallet.

The phased education plan includes the following steps:

1. Educate the participating agencies in the ecosystem in the problem, the technology, and the solution and its short- and long-term impacts.
2. Hold education sessions and focus groups with the school and service providers involved in the three AWARE pilots.
3. Hold education and focus groups with a select group of parents and guardians involved in the three AWARE pilots.
4. Plan and execute a limited pilot use of the guardian consent MVP solution and follow-up to solicit feedback.
5. Train the three AWARE pilot sites and the set of guardians, school officials, and service providers on use of the pilot solution.
6. Work with the various agencies to plan and execute roll-out of the solution which includes appropriate training, support, and feedback.

User recruitment plans

The impact from this work requires the solution to be adopted and used by state agencies, schools, and service providers. Thus, the challenge is one of organizational and ecosystem adoption versus user recruitment per se.

As depicted in the figure below, the adoption process occurs top-down:

1. The solution is initially adopted by the major entities (specifically NDE and NDHHS) through a methodical process of piloting and roll-out.
2. Entity adoption will drive use by the various community service providers.
3. This will expand use of guardian consent VCs to larger guardian populations.

Figure 4: Adoption Process



Partnerships with NDE and the Fostering Connections in Education Initiative is key to achieving this adoption in Nebraska.

Impact

To date, the project's implementation is just now ready for feedback from the field via focus groups. Thus, no field impacts have yet been achieved.

The project has made great strides in educating the state education agency on the potential applications of the technology for education and is working to incorporate the blockchain applications into their roadmap.

TECHNOLOGY APPROACH

During Phase 1, centered on a Guardianship VC, the project focused on Hyperledger Aries as a highly-visible, open-source blockchain infrastructure with multiple implementations and a good "story" for interoperability.

For Phase 1, the project chose the Trinsic platform as providing an approachable development experience for VCs, compared to other options. The platform provides higher level functions for the following:

- Create connections, end-to-end encrypted channels between two parties.
- Issue credentials based upon a schema posted to the ledger.
- Revoke credentials based upon revocation registry.
- Digital wallet with SDKs supporting multiple languages and supporting mobile and cloud wallets.

- Selectively disclose credential data in the presentations provided to Verifiers.
- Verify the VC presentations provided.

These higher-level functions essentially do most of the work (~ 3/4) - only requiring code (~ 1/4) to implement the VC specific application. The Trinsic Core v1 is designed to be cross-platform, supporting JSON credentials, CL signatures, Hyperledger Aries exchange protocols, and DIDComm v1. The Trinsic Wallet SDK was used to develop a mobile experience using Flutter.

The Phase 1 MVP development was successful, but the experience was rocky. While generally satisfied with the level of abstraction provided by the API, documentation and support were less than ideal.

Phase 2, addressing a Guardian Consent Verifiable Credential, surfaced new challenges:

- The design for the Guardian Consent has the VC issued by an individual, the guardian. Trinsic requires credentials to be issued by organizations. In fact, most VC applications in the ecosystem are based upon organizations, not individuals to be issuers. Trinsic, built upon Hyperledger Aries, also requires that each issuer posts the VC schema to the ledger. This approach was rejected as being a bit heavyweight.
- A Guardian Consent VC is requested by a Service Provider with a payload that can have a significant amount of information that defines the parameters of the consent. Trinsic significantly limits the data in a request for a credential.
- The presentation for Guardian Consent needs to, in some fashion, “wrap” the Guardianship VC in that the Consent is valid only is 1) signed by the guardian, 2) with a verifiable guardianship, and 3) has the student as the subject of the guardianship. Trinsic did not support a mechanism to link/wrap these upstream credentials in a manner that can be verified in a single step. Note, in the meantime, BBS+ was emerging a preferred signature that supports this type of verification.

These challenges required additional flexibilities that prompted a move to the DIDKit technology stack that was at a lower-level abstraction, requiring more development (~3/4) to achieve the desired results. DIDKit is a cross-platform set of services for W3C VCs in JSON-LD and W3C Decentralized Identifiers. DIDComm v2 support and BBS+ signatures are on the near-term roadmap. Their Credible Wallet is a light-weight, open-source white label wallet that is appropriate for wrapping a user interface in Flutter.

Interoperability

The project was conceived with a firm commitment to standards and interoperability. While standards are a necessary (but not sufficient) requirement for interoperability, interoperability is only achieved through the coordinated behavior of the ecosystem. Specific requirements are:

- Interoperability can only be achieved if enough vendors have business models that promote openness and interoperability.
- Interoperability is not solved by a single standard but depends on a collection of standards at different levels of protocol.

- Requires commitment to support different versions of each standard as they each evolve.
- Requires automated conformance tests at all levels.
- Interoperability is only achieved when different solutions can demonstrate and maintain interoperability.

The project's experience indicates that interoperability is currently a goal for the blockchain community that has not yet been achieved.

- Initial use cases are being driven by large enterprises that are driving solutions that are not (in a pure sense) platform-neutral, blockchain-neutral, and vendor-independent, and thus have asymmetric interoperability objectives.
- The various standard efforts led by the W3C are still incomplete and early in their maturity. The variety of business models being pursued taints the standards development process in prioritizing aspects needed for less-than-interoperable solutions.
- Many of the technical foundations for interoperability such as portable wallets, confidential storage, selective disclosure, and revocation are still very much under development.

Without a clear foundation for interoperability, the project pursued interoperability in the following ways:

- Commit to follow the standards that are key to the project's problem domain, such as VCs.
- Lacking any standard for a Minor Guardianship Verifiable Credential, design the credential to submit for comments as a future standard.
- In selecting a technical stack, favor those activities and organizations that are seemingly pursuing interoperability.

Standards

The project's strategy for standards and interoperability consisted of:

1. Select a technology stack that is committed to standards and interoperability at the lower levels of protocol.
2. Focus attention on the higher-level VC-related standards, including:
 - a. Conform to the W3C VC Data Model 1.0.
 - b. Field names will first look to conform with those in schema.org and aliased to those in schema.org where appropriate.
 - c. Extensions to the VC for the minor guardianship VC and the guardian consent VC will be defined using JSON-LD.

By focusing on the application layer, the work in VC definition and workflows can be retargeted to different technology stacks, as needed.

Migration to yet another technology is likely later as these areas mature.

LESSONS LEARNED

Technology lessons learned

From a technology viewpoint, lessons learned are as follows:

- Self-sovereign Identity (SSI) and Verifiable Credentials (VCs) are powerful concepts with many education domain applications, including guardianship and guardian consent use cases.
- Self-sovereignty, the fundamental principle of VCs, should become a broader mantra for applications – putting individuals in control of their own data.
- The underlying technologies supporting SSI and VCs are emerging, rapidly advancing, and immature.
- It can be a real time saver making use of a vendor's layers of abstraction over the underlying technology. On the flip side, you are now completely beholden to the vendor's layers of abstraction and must stay within those constraints.
- The standards developments led by the W3C, and others, are similarly early in their maturity, with version 2.0 standards based upon a deeper base of experience just now becoming available in some areas.
- As discussed above, interoperability in this ecosystem is a goal that cannot yet be achieved at scale.
- Early implementations (and therefore the technologies and standards) are being driven by large commercial and government business models that do not reflect unselfish self-sovereignty and interoperability interests.
- Integration with backend systems and processes will be key for large-scale deployment.

Overall methodology lessons learned

The project's overall methodology had many positive aspects:

- The solution was driven by the deep domain knowledge of the problem space where internal knowledge was augmented by direct connections to practitioners in the field.
- The development of a solution was concurrent with defining and refining the design of the VCs. This allowed both to advance concurrently, considering both the technical realities and constraints along with the complexities of the guardian consent VC application.

However, the project underestimated the time to understand, evaluate, adopt, and apply the technologies to the problem space. This was compounded because the consent use case forced a reimplementing using a second technology base.

Challenges faced/overcome (or not)

A summary of specific challenges faced:

- Guardianship is complex. The project overcame this with additional interactions with subject matter experts and research.
- The learning curve for blockchain technologies is steep – an effort underestimated by the project.
- Blockchain standards and technologies are immature, requiring compromises and workarounds along the way.
- With the consent VC application, the project faced the challenge of trying to build a real-world solution that goes beyond the simple scenario of an organization issuing a credential to a person who presents it to someone else. Current implemented technologies for SSI and VCs do not seem to be ready for person-to-person interactions in any sort of standardized way.
- With the technology offerings touched, bugs exist that are difficult to troubleshoot from the outside. Head-scratching problems surfaced frequently that there were bugs in products. How anyone could be building real solutions without also running into these issues? Overcoming these issues required support from the vendor.
- There are not established business models for this type of equity-centered, high-stakes-privacy, public-sector application. While not an impediment for this early effort, this remains an open item.

Best practices identified

A flagship of this work is a draft standard for a Guardianship VC and its Trust Framework. Having a lack of an acceptable standard for guardianship, approaching its development under the objective of creating a future standard urged the effort to research design and document the work in a more thoughtful manner.

Doing so with the close collaboration of partners and subject matter experts in Nebraska was key to success. The next step is to publish and request comments from the community.

Things we wish we knew prior to starting

In hindsight, the project did not understand just how nascent the blockchain space is. Standards are still evolving, business models are being tested, and technologies are immature, though rapidly advancing.

When trying to make decisions, the research often led to lengthy reads of proposed standards or discussions containing suggestions of standards that should be implemented.

Advice to those seeking to replicate

For those coming into SSI and VCs from the “outside,” be prepared to do a lot of reading and experimentation; be prepared to exit your comfort zone technically.

Unless you're doing something simple or cookie cutter (i.e., organization issues credential, user holds credential, user presents credential to 3rd party organization), be prepared to spend a lot more time trying to piece together a solution than you would in other areas of technology.

Plan on evolving a solution through waves of re-implementations to take advantage of emerging trends, technologies, and standards. Due to technology immaturity, it is unlikely that your initial technology decisions will be able to be evolved into whole, scalable, deployable solutions.

Next Steps

The project's planned next steps are as follows:

- Introduce and nurture an industry standard for a Minor Guardianship VC.
- Pioneer, educate, and advocate for the legal acceptance of consent VCs.
- Pilot, evolve, and deploy guardianship and consent VC solution in Nebraska, working with them to implement the required policy and process changes.
- Integrate with Nebraska infrastructures for data sharing.
- Expand Nebraska blockchain application in K–12 to include verifiable learning credentials and other blockchain applications.
- Expand Nebraska blockchain applications to Early Childhood focusing on cross-agency use cases.
- Share findings and implementations via open source.
- Expand the reach, adoption and impact via multi-state collaboratives championed by successes in Nebraska.
- Raise funding to continue the technology and solution development and enable the Student1 non-profit to provide grants for adoption and adjacent solution developments.

The Education Blockchain Initiative: Final Report

APPENDIX C

The Lifelong Learner Project,
Powered by Teachers



RANDA Solutions

Overview

The Lifelong Learner Project, Powered by Teachers, empowers every learner, at every age by imagining the educator at the center of every interaction. From a desire to impact students to sharing a passion for their subject matter, teachers are the leaders responsible for the future.

The Lifelong Learner Project ecosystem gives teachers agency and control over their verified teaching credentials, certifications, and the learning resources they collect. Control of their own information will allow educators to connect directly with teaching positions in classrooms or virtually. Breaking down the four walls of the school building provides economic mobility for educators by providing expanded opportunities to impact students across schools, districts, and states.

Teaching is an underserved career sector. *U.S. News & World Report* found evidence that teachers are leaving the profession at historic levels, which is only made worse by the ongoing pandemic. A lack of reciprocity between state teaching licenses impacts an educator's mobility and their ability to broker their skills into underserved and disadvantaged populations. For example, a rural school district is unable to offer Advanced Placement courses because there is minimal desire for this course. A virtual teacher with experience and expertise in Advanced Placement curricula could offer multiple districts this opportunity.

In addition to teachers being underserved as a whole, the percentage of teachers of color teaching students of color is dismal. The profession is now working hard to recruit teachers of color and provide them with pathways to career success and leadership which can be facilitated by the Teacher Wallet.

Providing educators with agency over their professional data, a blockchain-based wallet can transform the teacher marketplace. The career portfolio of a teacher can go beyond licensure and accurately describe the specific skills and interests that allow an educator to have maximum impact on student outcomes.

Market validation is overwhelming. According to *Education Next*, April 2011:

“A teacher at the 85th percentile can, in comparison to an average teacher, raise the present value of each student's lifetime earnings by over \$20,000—implying that such a teacher with a class of 20 students generates over \$400,000 in economic benefits, compared to an average teacher, for each year that she gets such achievement gains.”

-Eric A. Hanushek, senior fellow at the Hoover Institution, Stanford University

Anecdotally using this calculation and the current reach of this project, three thousand highly qualified teachers each impacting twenty students per year and thus increasing their lifetime earnings by \$20,000 equates to \$1.2B in economic benefits for students.

Using blockchain architecture, a digital wallet solution will ingest over eighteen different data categories aligned with teacher credentialing, licensing, and exemplars of practice. API paths for each of these sources of data allow the teacher to publish from these source systems to the Teacher Wallet. The educator can then deliver their data to consuming systems including state licensing systems, HR, LMS, SIS, and Google Classroom with confidence the data is true and verifiable to the originating source.

Once a digital identity is established, there are multiple paths for the teacher. Today is a unique time of transition in the education landscape. Teacher shortages are on the increase with chronic absenteeism calculated between 36-40% according to The Brookings Institute and many others simply leaving the profession all together rather than adapt to the ever-changing COVID landscape. Giving teachers flexibility to identify how they want to teach is critical to retention of the workforce. The potential future integrated ecosystem can allow districts and schools to programmatically identify their open positions based on the student and teacher population, directly connecting with teachers throughout the ecosystem that best fits the students they are serving.

Current systems can do this work at a very rudimentary level. Identifying a teacher with a license and a certificate to teach second grade exists today. However, the number of documented credentials is experiencing continuous exponential growth. This exponential growth has yet to be leveraged in a digital identity solution. Documenting, verifying, and associating similar credentials to achieve a common understanding of the credential requires recognized standards and the capacity to track and manage the dynamic growth of credentials, competencies, and learning badges. By aggregating the massive number of credentials workforce stakeholders can evaluate competency and align resources with opportunity.

Teacher Wallet delivers agency, control, and immediate access to a teacher's transcripts, recommendations, diplomas, coursework, program status, licenses, credentials and micro-credentials, certifications, continuing education, assessments, endorsements, student learning, teacher effectiveness, work history, lesson plans, curriculum maps, work product, and any other information the teacher chooses to place in their wallet. Verifiable credentials are added to the wallet and validated by the issuing entity, which means the burden is not on the teacher to individually contact, source, and validate the credentials. In addition, self-assertion or proof management tools can widen the professional data a teacher can consume, store and share.

Led by RANDA Solutions, a pioneer in education management solutions for statewide implementation, The Lifelong Learner Project is poised to unlock lifelong learning for educators and every student they impact. A digital identity solution focused on educators and offered through a comprehensive ecosystem including diverse blockchain architecture providers, who will be transaction providers, will bring to market a Teacher Wallet that is sustainable and a model for standards-based, interoperable blockchain technology.

Ecosystem First

The Lifelong Learner Project provides an ecosystem focused on educators' agency over the data reflecting their professional practice throughout their lifetime. An inclusive, interoperable architecture focused on educators and offered through a comprehensive ecosystem provides individuals and organizations an integrated network of support that is standards-based, sustainable, and interoperable.

Being part of this collaboration reflects an organization's support and investment into the next generation of teaching credentials and reflections of practice to lead what is shaping up to be a period of intense change and growth for education systems. This leadership effort on the cutting edge requires open-minded values, deliberate contribution, and action. The creative talents and innovations brought by all members will ensure the success of The Lifelong Learner Project.

Table 1: Ecosystem Members

	ORGANIZATIONS	DESCRIPTION
Wallet Creation	Digital Promise	The leading provider of micro-credentials for teachers.
	ETS	Representing the entire portfolio of PRAXIS exams, ETS is the beginning of a teacher’s lifecycle of practice in 40 states.
	Utah DOE	A leader in the education ecosystem, Utah recognizes the importance of data agency and aligning the discreet connections between teacher and student.
	University of Colorado Colorado Springs	Higher education innovator in the blockchain and security fields.
	University Instructors	With over 20 years of direct educational experience, we are experts at training and placing qualified educational talent into today’s classroom.
Transaction Providers	RANDA Solutions	A pioneer in building data and workflow management system for statewide teacher licensure and efficacy.
	BlockFrame	A foundational cryptographic data exchange, BlockFrame has built one of the most efficient blockchain architectures allowing for the scale necessary for this approach.
	Evernym	Helps organizations all over the world build trusted digital relationships.
	Fluree	Organizes blockchain-secured data in a highly scalable, highly insightful graph database.
	IdRamp	Provides decentralized identity solutions to simplify operations, improve security and continuously innovate business.
	Velocity Network Foundation	VNF is endeavoring to build out the community even further bringing together ecosystems already established such as Kelly Services filling 3.5 MM substitute teacher positions as well as other recruiting systems serving this population.
Integration	Crocus	Crocus built the foundation of the TPDM (Teacher Prep Data Model) creating a clear interoperable data exchange between EPPs and districts, connecting future teachers with their classroom experience and informing EPPs of that experience.
Standards	IMS Global	Leveraging the CASE Network of standards and the CLR (Comprehensive Learner Record) data standard adopted by AACRAO provides the interoperable package of credential assertions.
	IATC	International Alliance of Trust Chains (IATC) provides neutral governance for blockchain/distributed ledger adoption worldwide.
	Credential Engine	Making <i>all</i> credentials transparent and revealing the marketplace of credentials.

In addition to the founding members, new organizations continue to join The Lifelong Learner Project. Recent members include:

- **Learner's Edge** — From the first course we ever offered, Learner's Edge has been leading the way in providing educators with the most flexible, dynamic, and timely continuing education graduate courses to advance teacher skills, career objectives, and classroom instruction.
- **Educational Impact (EI)** — EI welcomes you to the world of online professional development. We encourage you to use the power of technology and the internet to create blended learning opportunities for administrators, teachers, and university students.
- **Idatafy/SmartResume** — Discover and connect with certified job talent without bias and without barriers. SmartResume® allows you to post jobs, search for qualified job candidates, and discover pools of certified job talent in a way never before possible.
- **Rick West** — Associate Professor, Brigham Young University, Instructional Psychology and Technology.

Membership in The Lifelong Learner Project has no associated fiscal cost, but rather requires a commitment of both thought leadership and your specific expertise to drive adoption and innovation with those lifelong learners it seeks to serve.

Methodology and Implications

The Lifelong Learner Project has developed an iterative, ecosystem first approach to drive inclusivity at the onset of this effort. At any intersection of this project there are at least two stakeholders with practical yet somewhat divergent approaches to the goals represented here. The participants in this ecosystem are all iterative, forward thinking, inclusive entities that have been driving these efforts in many communities for years, and through this project now have the unique opportunity for that work to intersect rather than diverge as it has in the past. The Lifelong Learner Project is “developing in public” and building in real time the business rules, data constraints, and flexibilities necessary for such a project to succeed and deliver value to the community it is designed to serve, but also to serve as a representation of inclusive, convergent, aligned approaches to build out an ecosystem. This includes weekly design, demonstration, and workgroup efforts to ensure that alignment and inclusive approach.

Through this project, individuals soon will have the ability and desire to receive, maintain, deliver, and verify evidence of their professional learning and represent that to consuming systems as a verifiable credential. The core of this interoperability lies in the ability for that user to acquire and maintain, where applicable, a decentralized identity (DID) in which they can assert information about themselves securely and verifiably. Further, these assertions must not only be machine readable but human readable as well. These items in mind, this project brings forth five different but interoperable approaches to meet these goals. In leveraging a best of breed approach to these, interoperability will be the default of The Lifelong Learner Project, not an afterthought.

Interoperable at its core, this ecosystem enables the user to publish these credentials to multiple mobile block-chain-based wallets. This approach forces interoperability from the onset of a user requesting their credential to the final system consuming and presenting those data to the user and a licensure specialist in the consuming system. The use of flexible standards is a requirement to accomplish this goal. Work with the following organizations on implementing standards that will work comprehensively across the solution has allowed the implementation of a truly interoperable “belt and suspenders” approach:

- IMS Global – Comprehensive Learner Record Open Badge 2.0
- W3 CCG – Verifiable Credential
- Credential Engine — CTDL
- Velocity Network Foundation
- T3 Innovation Network – Learning and Employment Records

The following diagrams demonstrate the role each ecosystem member plays in the development of the Teacher Wallet solution.

Figure 1: ETS Workflow Overview

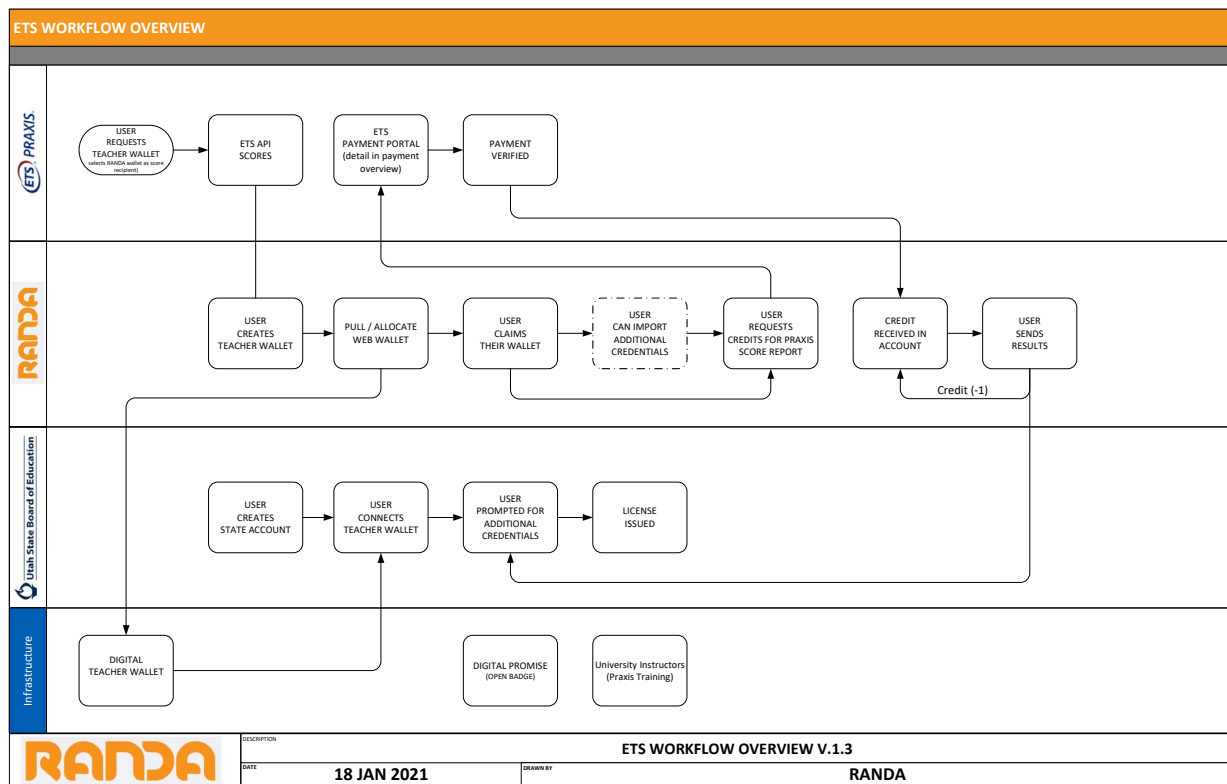


Figure 2: Digital Promise

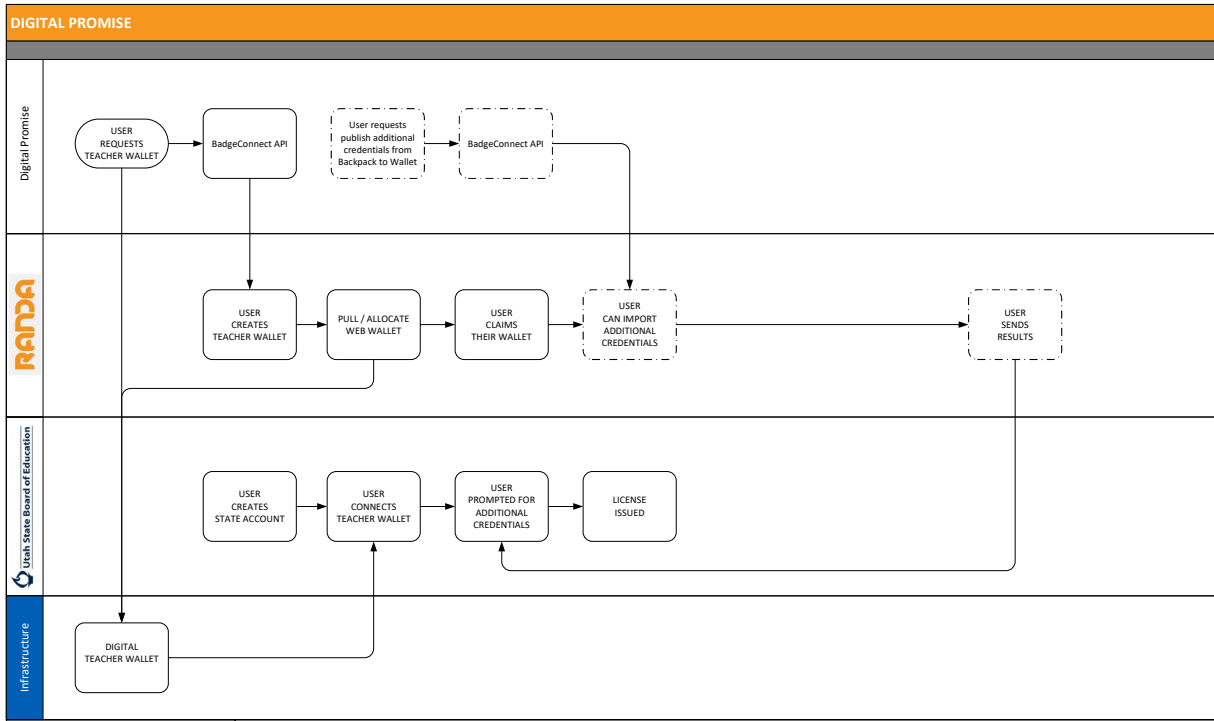


Figure 3: University Instructors

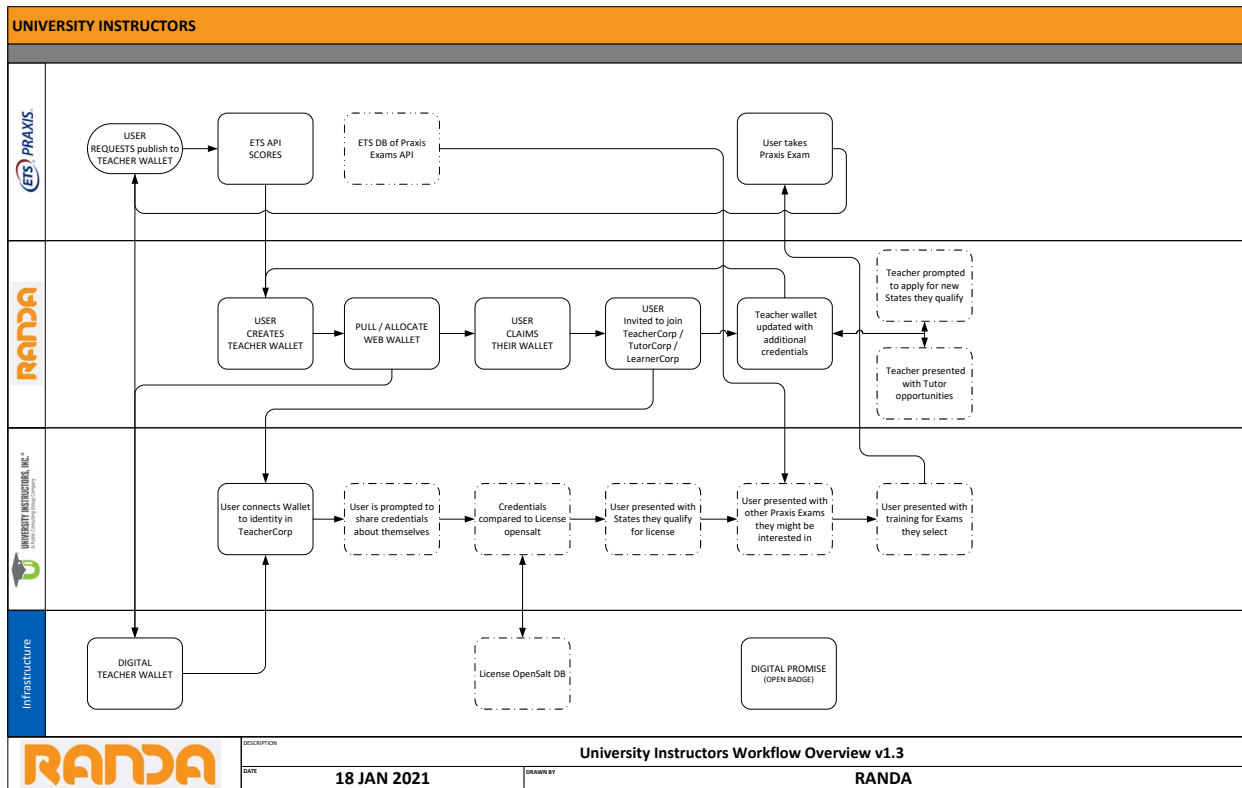
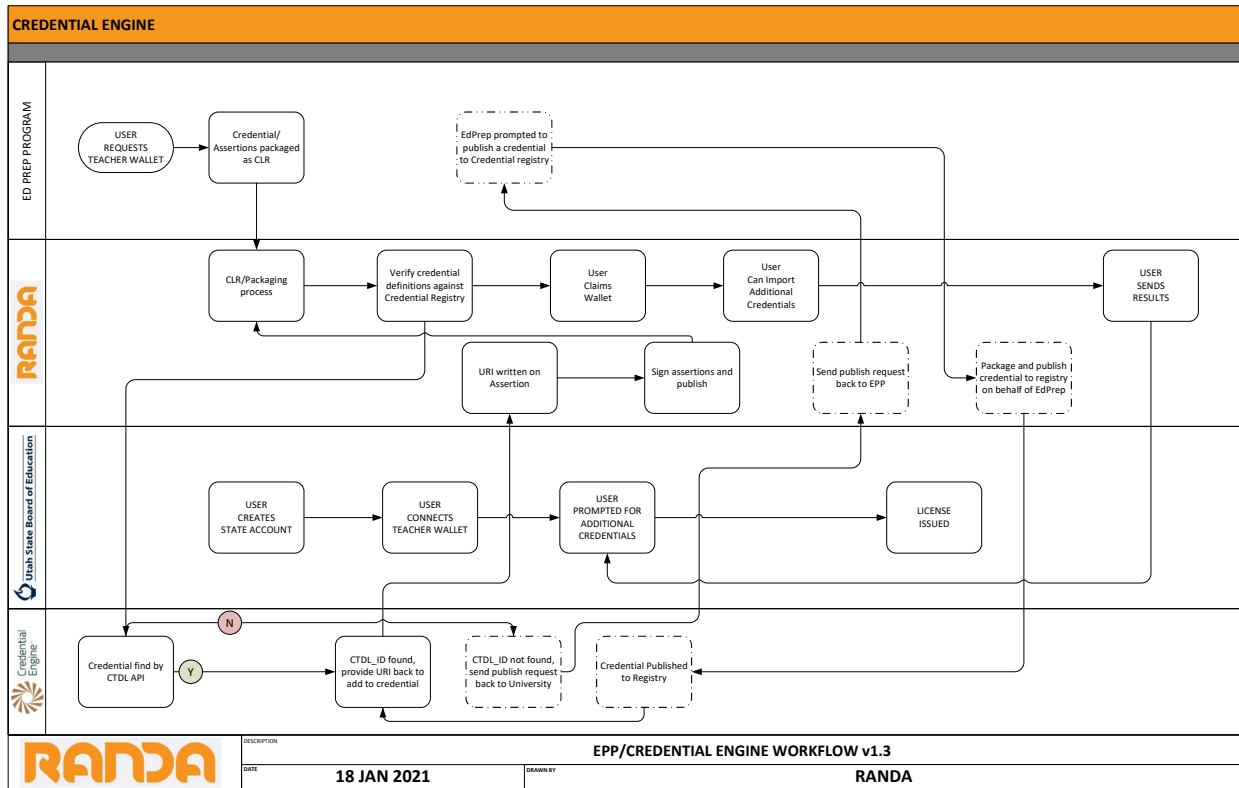


Figure 4: Credential Engine



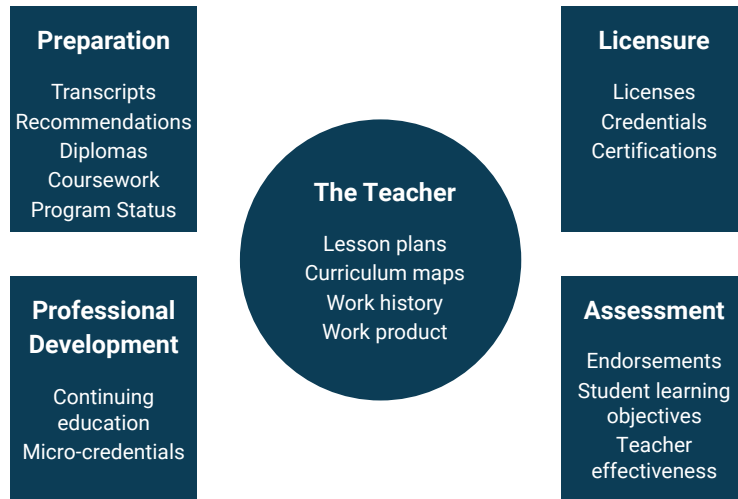
Reviewing these diagrams frequently in meetings allows ecosystem members to reflect on their roles and provide both expertise and insight around their specific contribution point.

Results

The ecosystem first approach is what has made The Lifelong Learner Project, Powered by Teachers, successful. In fall of 2020, RANDA Solutions met with stakeholders from many different sectors to identify members of this community.

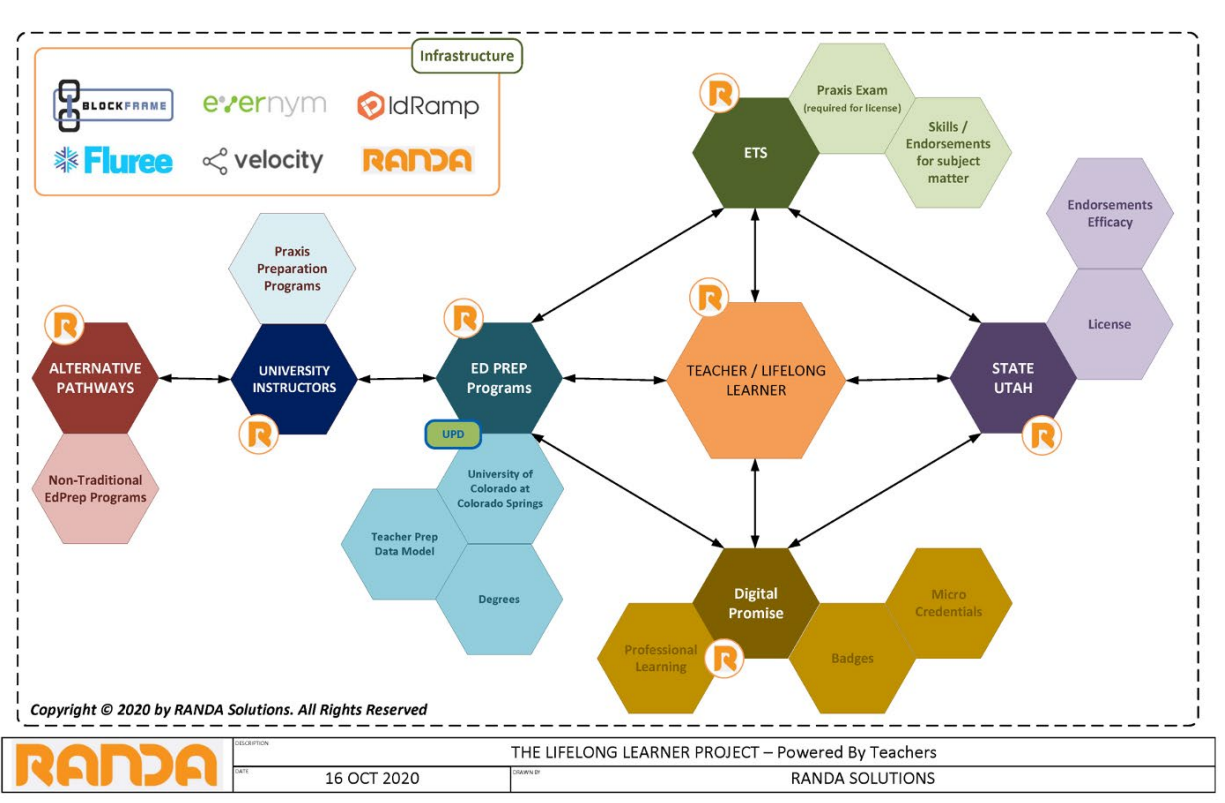
This initial illustration helped to frame how the original ecosystem members would contribute to the overall project.

Figure 5: A Teacher-Centered Ecosystem



Over time it grew into a more robust representation as partners who aligned with the vision of The Lifelong Learner Project joined and took their respective positions.

Figure 6: Teacher Centered Ecosystem



However, the vision of the teacher at the center of the ecosystem remained consistent and is the driving force behind the work of all partners. These partners felt so strongly about the vision for The Lifelong Learner Project that regular meetings began before the award announcements were made. These meetings focused on the goals for the community and establishing a roadmap for success.

Ongoing teacher focus groups were enormously helpful to understanding recruitment, adoption, and education of teachers' wallet holders.

Focus group attendees reported:

- Personal qualifications are stored in multiple places
- There is no way to verifiably reflect a teacher's additional responsibilities - leadership, curriculum committee, supervising student teaching
- Professional development experiences are lost and the details difficult to remember
- A portfolio of professional credentials would be valuable
- A portfolio would be used for organization, storing, recertifying, and seeking new opportunities

A primary goal of The Lifelong Learner Project is to implement a solution that is chain agnostic. Solving this challenge requires more than just creating a flexible interoperability later but necessitates architecting the solution to fit many different schemas and platforms.

Architecting a solution that solves the problem in a user-friendly way is challenging when the technology is nascent and evolving as quickly as blockchain. It is critical for those working in this space to be participants in moving the technology to a mature and robust phase before widespread adoption will be possible.

Trying to find a common vocabulary that articulates the values of the ecosystems, addresses the challenge it is attempting to solve, and is easily understood and adoptable by the end user is critical. This common vocabulary must be established in an intentional manner with consensus from stakeholders.

Adoption needs to occur in phases. Because the technology is so new, there is learning that must be done in each phase in order to refine the product to meet the real needs of its user. Adoption from zero users to thousands will prevent this iteration from occurring in real time as user experience dictates.

Implementing this technology in the right way takes longer than expected. Fledgling technology and burgeoning standards are changing rapidly. There is a need to contribute to the overall technology ecosystem and be flexible enough to pivot when necessary to a different methodology to reach the end goal.

A few key principles and practices surfaced as especially critical to the ecosystem's success:

- **Project co-lab.** Regular meetings with the entire ecosystem with alternating agendas to cover technological updates, build ecosystem consensus, and create adoption strategies.
- **Teacher focus groups.** Discussion with education professionals in various stages of their career life-cycle allowed challenges to be clarified so that the solution could be built "with" rather than "for" the users it intends to serve.

- **Frame the problem quickly.** Having an image of a teacher’s paper portfolio allowed us to convey in only a few seconds the massive challenge that educators have about collecting, storing, and sharing their professional credentials. It is imperative that the real-world problem is quickly relatable to not only the people experiencing the headache but also stakeholders and the general population.
- **Community outreach meeting.** Providing the larger interested community with an opportunity to learn more about The Lifelong Learner Project allowed for ecosystem expansion. It had over 60 attendees and the recording has been viewed on YouTube 119 times.
- **Dynamic ecosystem.** Our flexible ecosystem has continued to expand during the phases of the Blockchain Innovation Challenge with additional members joining.
- **The Lifelong Learner Project website.** Having a simple website has allowed us to share The Lifelong Learner message with many more individuals and a webform has allowed us to capture the interest of the community and provide regular updates.
- **Get the right people on the team.** Make sure that the team has a balance between technologists and practitioners. This will allow you to make sure the solution being built actually solves the problem.
- **Collaboration over competition.** Because this technology is fledgling there is ample room for everyone to participate in how it is adopted in the future. By letting go of competition and working together projects can be both affordable and interoperable by design.

Next Steps

The Lifelong Learner Project ecosystem continues to expand, and the work will be ongoing. Teacher Wallet is currently being implemented with alpha users and those lessons will assist The Lifelong Learner Project with feature enhancements to increase adoption and market viability.

- **Credential publishing.** A key focus of the current product is to increase the number of credentials being published to Teacher Wallet. As new ecosystem partners join, their credentials are being configured and integrated into the current solution.
- **Interstate compact.** The Council of State Governments in partnership with the Department of Defense selected K–12 teaching for technical assistance with the development of an interstate compact for occupational licensure portability. This portability will allow teaching professionals to transcend state boundaries by creating uniform standards of practice. Teacher Wallet is poised to provide a mechanism for the collection and proof management of licensure components which will greatly accelerate this initiative.
- **Special populations.** The Lifelong Learner Project has uncovered several special populations that will be impacted by the ability to assert control over their professional data. These special populations include:
 - » Military spouses — Due to frequent relocation these individuals face significant challenges to entry in state-licensed professions.

- » Rural educators — The educators possess skills that transcend the four walls of the classroom and because of the new virtualization of education can have wider impact by brokering skills to multiple districts.
 - » Novice teachers — Entering the profession of teaching requires a significant number of achievements and these educators need a simple solution like Teacher Wallet.
 - » Paraprofessionals — The pathways for these educators are unclear. Educators need a clear way to see the credentials needed for the positions and opportunities they seek.
- **Job boards.** An extension of Teacher Wallet and the work of The Lifelong Learner Project will be the addition of job board functionality so that states and districts have access to skilled professionals and educators have clear insight into opportunities for which they are qualified.
 - **Utah licensure integration.** The Lifelong Learner Project is working with the State of Utah Board of Education to extend The Lifelong Learner Project into a licensure solution allowing licensure specialists the means to verify applicant data directly from user's shared verifiable credentials.
 - **User experience.** The technical functionality has been the most important objective to achieve through the ACE BIC. Now as Teacher Wallet is adopted by individual educators, iteration will be required to create a user experience that is friendly and intuitive.
 - **Accessibility review.** Once user experience has been tested and validated, the application needs to undergo a thorough accessibility review to ensure that colors, buttons, and functionality are all accessible and inclusive by design.

The Education Blockchain Initiative: Final Report

APPENDIX D

The UnBlockEd Project: Leveraging Blockchain in Higher Education



UnBlockEd

Executive Summary

UnBlockEd is a collaborative research project funded by the [American Council on Education](#) through the [Blockchain Innovation Challenge](#) initiative. This research effort is being led by the [University of Arizona](#), in partnership with the [Georgia Institute of Technology](#), [Fluree](#), and the [John N. Gardner Institute for Excellence in Undergraduate Education](#).

PILOT PROJECT GOAL

The goal of this work was to prototype an open transfer exchange system that will facilitate student progress towards graduation by making the transfer articulation processes more transparent. The success of this effort will lead to student empowerment by leveraging the agency they gain through control of their learning records via the use of blockchain.

THE PROBLEM

Transfer articulation involves students petitioning one institution to accept previously earned academic credits from one or more other institutions (e.g., this is what happens when a community college student transfers to a university). Because courses and programs are constantly changing, and students commonly accumulate credits from numerous institutions, this is a highly complex problem. Indeed, students find it to be one of the most inefficient, opaque, and frustrating processes in all of higher education. According to the U.S. Department of Education, in 2018 there were approximately 17 million undergraduate students attending degree-granting postsecondary institutions in the United States, with roughly 6 million of these students enrolled in community colleges. Of these students, based upon historical data, one can expect about 35% of the total population will transfer at least once and 11% twice during their academic careers. In doing so, they will on average lose the equivalent of one year of course work with each transfer.¹ Furthermore, the transfer student population is disproportionately comprised of low-income students and students of color. Thus, the inefficiencies with transfer articulation constitute a significant inequity in higher education that must be addressed.

PROJECT DETAILS

UnBlockEd is an innovative approach for addressing inequitable transfer articulation issues that broadly undermine transfer articulation's promise. Students are empowered by giving them more control (self-sovereignty) over their own learning records, and by providing them with more knowledge and control over the transfer process. UnBlockEd uses blockchain in two ways. First, the UnBlockEd infrastructure is designed to connect and interoperate with emerging blockchain-based systems that allow students to directly share coalesced academic transcripts. Second, UnBlockEd involves the construction of a blockchain-enabled transfer exchange infrastructure that gives students earlier insights into how particular courses transfer to specific programs at target institutions. This, in turn, will incentivize institutions to more clearly articulate the requirements associated with their degree programs, as well as the credits they are willing to accept. The UnBlockEd design integrates a newly developed transfer articulation capability that leverages curricular analytics to create

efficient cross-institutional degree plans. A prototype minimum viable product (MVP) based on these features has been deployed at <https://BIC-UnBlockEd.org>.

LESSONS LEARNED

- **The pain is real.** The surveys that were collected and the focus group feedback confirmed that both community college administrators and transfer students wholeheartedly agree with the significant need for improvements related to transfer articulation. That is, students suffer significant “pain” due to the inefficiencies associated with transfer articulation that could be alleviated by this work.
- **It’s not just that the credits transfer—it’s how they apply.** There is a significant “gap” within the higher education community, state legislators, those in the education technology space, etc., about what makes transfer articulation so difficult. The project team continuously encountered those who felt the problem was “solved” once comprehensive course equivalencies were established between two institutions. Specifically, that by providing better and more extensive course equivalencies, students can easily transfer. However, the reality that students confront (confirmed by student focus-group feedback) is that even when courses transfer to a receiving institution, they often end up as excess credits that do not apply towards the satisfaction of degree requirements. Worse yet, students often do not discover this until *after* they have transferred, and they end spending a year or two more in college than they had anticipated (if they complete at all).
- **Maturation of blockchain-based technology in higher education.** Although there has been significant press around the use of blockchain in higher education, no viable open-source solution has emerged for storing transcript-level data. For example, Blockcerts currently does not contain the level of detail necessary for reasoning over transfer articulation scenarios. To mitigate this risk, the project team designed the pilot system to work with W3C standards related to Decentralized Identifiers (DIDs) and Universal Wallets for storing student transcripts within any emerging blockchain infrastructure. There are a few early efforts related to the AACRAO-supported Comprehensive Learner Record (CLR); however, these are too early in the development process to prove viable. The plans are to monitor progress in this area and to work with any emerging solutions.
- **The need for standards around course equivalencies and degree requirements.** The ability to obtain “clean” degree requirements data from institutions has proved far more difficult than anticipated. This data is commonly housed within institutional degree audit systems (often as rules), but extracting this information in the required form is often not possible, necessitating the need to perform manual data entry. There are other efforts aimed at making this data more accessible that the project team may be able to leverage in the future. The ability to develop standards around the storing and communication of degree requirements is sorely needed in higher education. Furthermore, the ability to do this using emerging linked data formats (e.g., JSON-LD) will provide avenues to more easily link this data to other application spaces within higher education. Thus, the project team developed an open JSON-LD-based framework (using CTDL) for storing both course equivalencies and degree requirements.

NEXT STEPS

The next steps in this work involve continuing to mature and develop the technologies along the transfer articulation pipeline. Specifically, the project team is currently working to deploy open digital wallet technologies on both the University of Arizona and the Georgia Institute of Technology campuses. Again, these are in the “early days” with respect to this technology, but some of the first items the project team hopes to store in these wallets are student transcripts. Members of the project team are also working to create improved optimization algorithms to support the two main use cases involved in this work: completion mapping and two-year to four-year articulation agreements. In addition, the project team will be developing improved web-based user interfaces, based upon student feedback, to support these two use cases.

Introduction

The UnblockEd project provides an innovative approach for addressing inequitable transfer processes and practices, issues that broadly undermine transfer articulation’s promise. Transfer articulation is the most inefficient, opaque, and frustrating process in all of higher education. Transfer articulation involves students petitioning one institution to accept (i.e., recognize) previously earned academic credits from one or more other institutions. Ideally, these “prior credits” will satisfy some of the degree requirements associated with the academic programs students are transferring into. Prior credits accepted as transfer credits in degree programs enable students to proceed more efficiently towards on-time graduations. There are, however, myriad reasons why prior credits are “lost” during the transfer process. Academic institutions are in fact fighting a losing battle in their current attempts to address this problem. This is borne out by the massive number of credits lost annually by transfer students.

Using an ecosystem-first design, UnblockEd empowers students by providing them with more knowledge and control over the transfer process. This will occur through the construction of a blockchain-enabled exchange that gives students earlier insights into how particular courses transfer to specific programs at target institutions. This, in turn, will incentivize institutions to more clearly articulate the requirements associated with their degree programs, as well as the credits they are willing to accept. This design will integrate a newly developed transfer articulation capability that leverages curricular analytics in order to create efficient cross-institutional degree plans. Furthermore, the UnblockEd infrastructure will be designed to connect and interoperate with emerging blockchain-based systems that allow students to directly share coalesced academic transcripts. Thus, **this system, for the first time, will yield an end-to-end system for transfer credit recognition in higher education containing an open transfer exchange that will dramatically improve the efficiency of the transfer process.**

VISION

The vision of the UnblockEd team is a nationwide transfer credit recognition system based on a permissioned blockchain structure that empowers students by effectively utilizing technology to dramatically improve the transparency and efficiency of credit recognition through transfer processes in higher education. The project

design empowers all students by leveraging the agency they gain through control of their learning records, in this case transcripts of prior or anticipated course work. Specifically, learners who have an interest in transferring prior credit-bearing work to a college or university will be able to supply their records to a blockchain-enabled transfer exchange. Colleges and universities, through their participation in the exchange, will be able to certify the authenticity of the records learners submit, but simultaneously they must reveal not only the credits they are willing to accept, but the manner in which those credits would apply in particular academic programs. This serves to equalize the information asymmetry that currently exists in transfer processes nationwide (described in more detail below), thereby eliminating a disadvantage that disproportionately impacts underserved students who are more likely to transfer.

By providing learners with earlier and more accurate insights into how their prior hard work will apply towards additional credentials, a more efficient and equitable transfer process is created. This efficiency will lead to earlier and better-informed decision-making regarding the courses a student should take and the institutions they should consider transferring to. By reducing the inefficiencies, as well as the concomitant learner disappointment, associated with the transfer process, students are far more likely to seek additional credentials and thereby engage in **lifelong learning**. A dramatic lowering of the barriers associated with transfer articulation thus improves the likelihood that underserved learners will earn additional higher education credentials, which continues to be the best means for **improving economic mobility**.

MOTIVATION

Administrators in higher education are reporting higher numbers of students seeking to transfer at least a year's worth of academic credits,¹ and one should expect this trend to continue in light of and response to the financial and human conditions brought on by the novel coronavirus (COVID-19) pandemic. However, many of the institution-centric attitudes and historical practices in higher education have impeded progress in this area.² Those practices have led to inequitable outcomes, which will only be exacerbated by the demographic shift that is underway in the United States, and by the aforementioned COVID-19 crisis.

How Bad Is the Problem?

In 2018 there were approximately 17 million undergraduate students attending degree-granting postsecondary institutions in the United States, with roughly 6 million of these students enrolled in community colleges.³ Of these students, based upon historical data, one can expect about 35% of the total population will transfer at least once and 11% twice during their academic careers. In doing so, they will on average lose the equivalent of one year of course work with each transfer.⁴ With the average annual cost of college tuition at \$3,500 (community college) and \$10,000 (university), this lost year equates to an annual excess tuition of more than \$50 billion. When lost opportunity costs related to wages, retirement savings, and student debt are factored in, the loss associated with transfer inefficiencies can be conservatively estimated to exceed \$150 billion per annum.⁵ It should also be recognized that the financial costs are only one part of the overall loss.

There are significant demographic factors at work in the inefficient transfer credit recognition pipeline—factors that explain why transfer is one of the most inequitable aspects of the postsecondary experience in higher education in the United States today. It has been shown that about 40% of first-time, first-year students start in community colleges and that first-year student enrollment in community colleges is proportionately higher than in any other postsecondary sector in the United States, even though community colleges represent only about a quarter of the institutions of higher education in the United States.⁶ Furthermore, students who enroll in community colleges are diverse in nearly every sense of the term: “Over two-fifths of Hispanic (42.6%), nearly one-third of African Americans (31.3%), nearly two-fifths of American Indians (39.3%), and nearly three-tenths (29.4%) of students who identify as belonging to two or more race/ethnicity groups are enrolled in community colleges. And over two-fifths (42%) of all low-income students who go to college in the United States, do so in the community college. This means that students of color and students from low-income families are overrepresented in a sector that, as previously mentioned, constitutes just about a quarter of all postsecondary institutions in the United States.”⁶

It is also worth mentioning that inequity seems to be magnified by the transfer process: “Lower income students at community colleges were essentially as likely as students from higher income families to earn an associate degree or certificate before they transferred to four-year institutions. But low-income students were much less likely to earn a bachelor’s degree after transferring than their counterparts from higher income families. Specifically, nearly half of community college students from higher income families (49%) earned a baccalaureate degree within six years of starting at the community college. Slightly more than a third (35%) of students from low-income families did.”⁶

Given these outcomes, and with community colleges disproportionately functioning as a primary entry point for students from historically underrepresented race and ethnicity groups and low-income families, there is, to put it mildly, a disservice being done to these students in the transfer process. The project team contends that this disservice has much to do with the hidden complexity of the credit recognition system and the extra time (and cost) that this system places on students who are least likely to be able to bear the burden of “articulation surprises.”

The fact that students are often not aware of how their earned credits might apply to particular programs until it was too late in the transfer process is a problem of information asymmetry.^{7,8} One can think of transfer articulation as a marketplace, where students are the buyers, colleges/universities are the sellers, and transactions involve the seller applying the buyer’s prior academic credits towards the satisfaction of degree requirements. In the current transfer articulation marketplace, the sellers have more and better information than the buyers with regards to the expected quality of these transactions. In a seminal paper, the problem of information asymmetry was illustrated in the market for used cars.⁹ In this case, the owner (seller) of a car tends to have much better information than the buyer regarding whether or not the car is a “lemon.” This information asymmetry leads to an inefficient marketplace that puts buyers at a distinct disadvantage in the relationship and increases the chances of adverse selection. In the case of the transfer articulation marketplace, the adverse selection issue is clear—students suffer financial loss if they choose a “lemon” program that recognizes little prior work and are unable to realize the issue until after they have “bought” the new college or university experience.

Why Is Transfer Articulation/Credit Recognition Hard?

With good intentions, many universities work with their community college partners to create transfer articulation pathways that provide a roadmap for students moving from one program (e.g., A.S. in biology) at a community college to a similar program (e.g., B.S. in biology) at a four-year institution. These are generally created under the assumptions that a student is starting the A.S. program without prior credits, that the two-year degree will be completed first, and that no curricular changes in the four-year program will occur while the student is pursuing the two-year degree. In reality, students often have a diversity of credits from different sources, they change their degree aspirations, and curricula are in constant flux as they are updated and improved. Thus, attempting to create transfer pathways that account for these variabilities is challenging to say the least.

Furthermore, the combinatorics associated with this problem quickly overwhelm any attempts to solve it by throwing more advising resources at it. Consider a typical state system involving six public universities and fifteen community colleges. Assume that each of these institutions has 100 programs, and one wishes to create transfer pathways from each of the community colleges to each of the universities. Further limit the number of transfer pathways from each program at a community college to only five programs at each university. Then the total number of pathways from the in-state community colleges to each university is:

$$15 \text{ CCs} \times 100 \text{ CC programs} \times 5 \text{ university programs} = 7,500 \text{ pathways.}$$

If only one hour is spent on each of these pathways, 3.75 years of a person's full-time effort would be required to create these 7,500 pathways, and the total effort to create pathways for the entire state would be 22 person-years. When one takes into account the "messiness" associated with each individual student's situation, and the time it takes to determine course equivalences, it is easy to see that this problem quickly becomes unmanageable. There is, however, good news. If the transfer process is set up properly, it is possible to turn it into an efficiently computable problem, as described in more detail next.

The UnblockEd Pilot Project

In this section a summary of the work undertaken on this project is provided based on using the support of the ACE Blockchain Innovation Challenge grant.

OVERVIEW

This project directly addresses the inefficiencies associated with the transfer process via the novel integration of a number of technical capabilities with newly emerging blockchain capabilities. In doing so, one can dramatically improve visibility into the transfer process. Phase 1 of this project involved the construction of a minimum viable product (MVP) that demonstrated the functionality of all key concepts associated with the exchange. The data in the exchange was pre-populated with degree programs and course equivalences from a number of the public colleges/universities in the State of Kentucky. Two use cases were demonstrated. The

first involved a student with prior credits earned at one institution and seeking to transfer them to a different institution, and the second involved building a two-year to four-year transfer articulation map. In each, relevant information from the exchange will be extracted, and curricular analytics will be applied in order to demonstrate how these credits would apply to any selected program in the state.

PARTNERS

The UnBlockEd Blockchain Innovation Challenge (BIC) project is a collaborative effort involving the University of Arizona, the Georgia Institute of Technology, Fluree PBC, and the John N. Gardner Institute for Excellence in Undergraduate Education (Gardner Institute).

OBJECTIVES

Phase 1 of this project involved the construction of a minimum viable product (MVP) that demonstrates the functionality of all key concepts associated with the end-to-end system. The data in the exchange was pre-populated with a few degree programs and course equivalences from public colleges/universities in the State of Kentucky. Two use cases were demonstrated. The first involved the creation of a completion plan after evaluating the courses extracted from a student's transcript. The second involved creating a two-year to four-year transfer articulation roadmap. In both use cases, relevant information from the exchange was extracted, and curricular analytics was applied in order to demonstrate how prior credits would apply to a program at the receiving institution. By sharing this compelling live demonstration with key stakeholders (students and universities) the project team will be able to collect important feedback that will be incorporated into future development plans. This will ensure the success of the pilot's full implementation involving a broader set of transfer process use cases.

Use Cases

The two uses considered in this project are documented below. The use cases were elaborated throughout the pilot project, and are as follows.

User Case 1: Transfer Credit Evaluation

Format: As a potential transfer student, I can determine how my prior coursework will apply towards the satisfaction of degree requirements by providing my transcript and selecting a specific target academic program on the UnBlockEd platform.

Task 1.1: As a transfer student, I need to be able to supply my transcript to a four-year institution, and select a program at the four-year institution that I'd like to complete. I need to receive back a completion plan that shows how my prior credits apply towards the satisfaction of degree requirements for the selected program, and the courses I need to take to complete the degree.

Result 1.1: I'll know this is complete when I receive an optimal transfer articulation roadmap, i.e., one that:

- Optimally accounts for prior coursework contained on the transcript;

- Satisfies all degree requirements associated with both the selected bachelor's degrees; and,
- The roadmap has the minimum number of credit hours required to satisfy the degree requirements.

Task 1.1.a: To complete Task 1.1, prior coursework needs to be read from a student transcript extracted from a blockchain-based data store.

Result 1.1.a: I'll know this is complete when I can read a student transcript and place the transcript data into the format required by the CurricularAnalytics.jl toolbox.

Task 1.1.b: To complete Task 1.1, data stores for degree requirements, courses and course equivalencies need to be made available (by college/university), along with the end-points for accessing them.

Result 1.1.b: I'll know this is complete when I can query these data stores through a web-based user interface and receive the correct results in JSON format.

Task 2.1.c: To complete Task 2.1, I need to be able to present the degree roadmap to college/university staff using HTML/CSS.

Result 2.1.c: I'll know this is complete when I can select a community college program and a university program from the UnblockEd.org website, and it returns results satisfying the conditions listed in Result 1 that can be rendered in a web page as an optimal two-year to four-year transfer articulation roadmap on the UnblockEd.org website.

User Case 2: Standard Transfer Articulation Roadmap

Format: As a community college or university staff member, I can create a two-year to four-year transfer articulation roadmap from any program at a community college to any program at a university by selecting an associate degree program from a community college and a bachelor's degree program from a university on the UnblockEd platform.

Task 2.1: As a college/university staff member, I need to access the list of associate degree programs at a particular community college, and the list of bachelor's degree programs at a particular university so that I may select one program from each, and receive a transfer articulation roadmap.

Result 2.1: I'll know this is complete when I receive an optimal transfer articulation roadmap, i.e., one that:

- Satisfies all degree requirements associated with both the selected associate and bachelor's degrees;
- All courses in the first two years of the roadmap are from the community college, and all courses in the last two years are from the university; and,
- The roadmap has the minimum number of credit hours required to satisfy the requirements of both degrees.

Task 2.1.a: To complete Task 2.1, data stores for degree requirements, courses and course equivalencies need to be made available (by college/university), along with the end-points for accessing them.

Result 2.1.a: I'll know this is complete when I can query these data stores through a web-based user interface and receive the correct results in JSON format.

Task 2.1.b: To complete Task 2.1, I need to be able to submit a set of courses from a community college, and a set of degree requirements for a bachelor's degree program at a university to an online service (web page that communicates with the service), and it returns a degree roadmap.

Result 2.1.b: I'll know this is complete when the roadmap that is returned satisfies the conditions listed in Result 1 above.

Task 2.1.c: To complete Task 2.1, I need to be able to present the degree roadmap to college/university staff using HTML/CSS.

Result 2.1.c: I'll know this is complete when I can select a community college program and a university program from the UnBlockEd.org website, and it returns results satisfying the conditions listed in Result 1 that can be rendered in a web page as an optimal two-year to four-year transfer articulation roadmap on the UnBlockEd.org website.

User Case 3: Reverse Transfer Articulation (future development, not included in the MVP)

Format: As a community college or university staff member, I can evaluate reverse credit articulation from a university to a community college by evaluating a student record “against” the set of degree requirements for a particular associate degree on the UnBlockEd platform in order to determine any university credits that could be reverse articulated back to the community college.

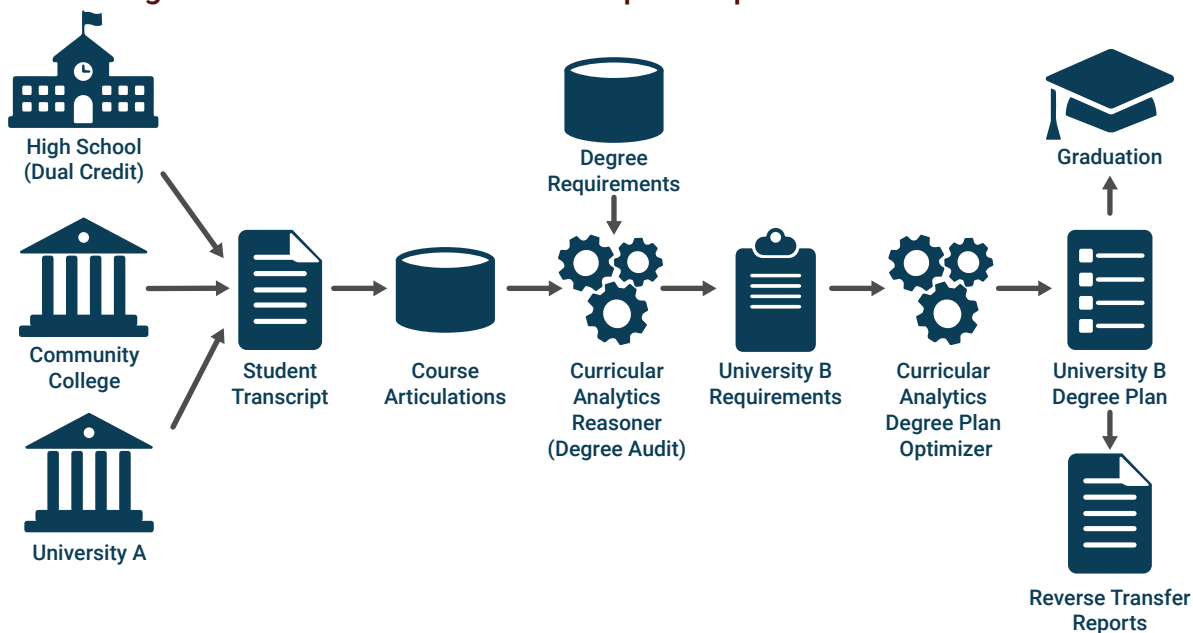
METHODOLOGY

Technology Approach: Ecosystem-First Design

The key technology that was developed in this BIC project is the distributed open source blockchain-enabled exchange for managing the college/university-specific data requirements associated with the transfer process. The approach is ecosystem first in the sense that the creation of the transfer exchange infrastructure, i.e., the ecosystem required for efficient credit recognition, will be used to create a marketplace that will incentivize use and drive adoption.

The use of blockchain in this exchange is significant because it enables the creation of a highly distributed ecosystem that leverages emerging blockchain-based credentialing efforts, while creating market forces that will empower students and encourage college participation. This ecosystem-first design will make heavy use of previously developed curricular analytics capabilities.^{10, 11}

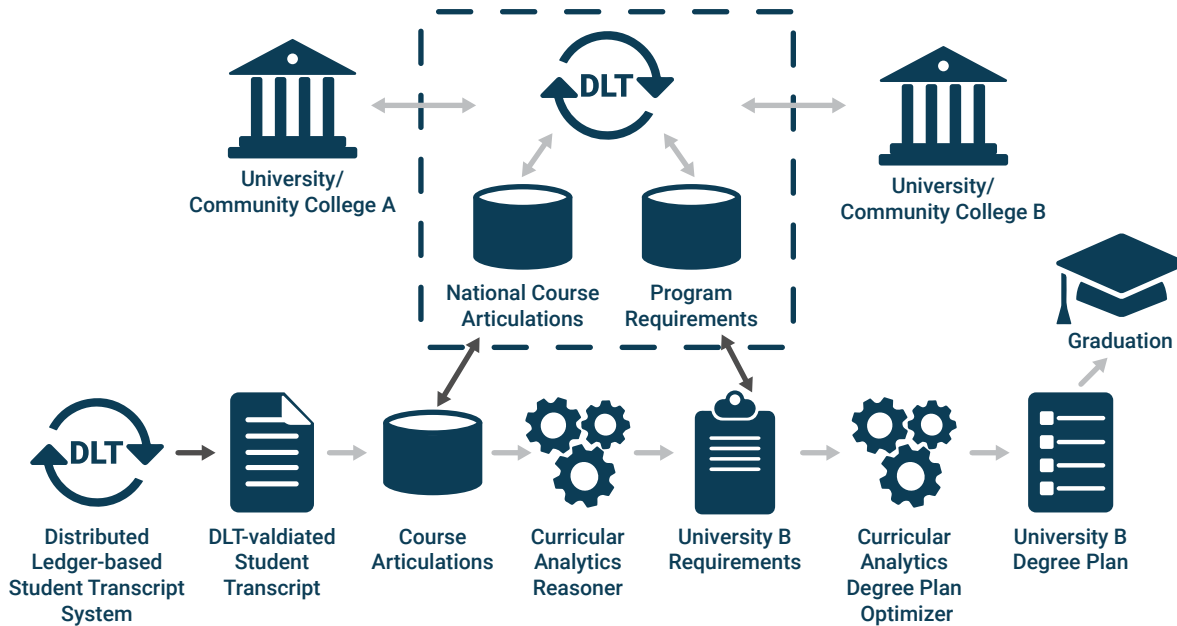
Figure 1. The transfer process capabilities supported by the Curricular Analytics Toolbox,¹⁴ demonstrating that transfer articulation is a computable problem.



Specifically, members of the project team have pioneered efforts that use network theory to quantify the complexity of academic curricula, and they have used the analytics derived from this work to directly quantify the impact that various curricular factors have on student success.^{11, 12, 13} Members of the project team have also released an open-source toolbox and web application that supports curricular analytics.¹⁴ This technology will be utilized to provide “reasoning” across the transfer process in the pilot implementation.

Most relevant to this project are the transfer articulation capabilities that have been developed and tested at the system level in the State of Kentucky. A high-level flow of these capabilities is depicted in Figure 2. Starting on the left-hand side of this figure, the notion that a student now routinely accumulates credits from multiple postsecondary institutions is captured. For instance, a student may earn college credits while in high school through dual credit programs, or transferrable credits due to participation in Advanced Placement (AP) programs. Furthermore, due to the prevalence of transfer, a student may have earned credits from one or more community colleges or universities. Ideally, these credits are reflected on some type of coalesced student transcript (more on this later), that can be evaluated by an institution a student may be interested in transferring to. Colleges and universities routinely maintain a database of the transfer courses they consider to be substantially equivalent to the courses offered at their own institution (as described above).

Figure 2. Integration of the exchange into the transfer process. The functionalities enclosed by the dashed box were developed as a part of the BIC initiative, as well as the interfaces represented by the darkened arrows.



Interoperability and Open Standards

This project involves integrating existing blockchain technologies provided by Fluree and existing transfer articulation technologies that are a part of the curricular analytics capabilities developed by co-principal investigators Abdallah and Heileman, yielding a compelling minimum viable transfer exchange product by the end of the Phase 1 effort. The tasks here mainly involve software development. Thus, the short timeframe associated with the Phase 1 effort was supported by an agile software development process involving weekly sync-up meetings and three software development sprints, each involving requirements analysis, design, and the implementation of a functioning prototype. The third prototype corresponded to the MVP demonstrating end-to-end functionality of the transfer articulation system.

The software development effort required to knit together the various components of the system was carried out by graduate students at the University of Arizona and the Georgia Institute of Technology, employees at Fluree, and software engineers hired by the Gardner Institute. The first prototype involved “hardwiring” together the existing functioning technology components. Successive refinements of this prototype will involve implementing additional features while always maintaining a functioning prototype. These successive refinements will involve building “live” interfaces between the existing technologies, as well as a React-based web front-end that will be used to interact with the transfer exchange. It is also important to note that the semantic overlay provided by the Fluree system will allow us to readily incorporate disparate data from other sources related to transfer articulation.

In order to create the foundation for the UnBlockEd ecosystem, previously collected data associated with the 16 community and technical colleges and eight public four-year institutions in Kentucky was used to pre-populate the UnBlockEd data stores. The software development work associated with this project utilized an open design (open source and open standards) that will enable interoperability with other systems, including open source curricular analytics tools. The project team will also develop in accordance with other open standards as necessary, such as those associated with W3C Verifiable Credentials (VCs), Decentralized Identifiers (DIDs), and Interoperable Learning Records (ILRs). This provides a sound structure for describing and distributing blockchain-based learning records—including variables such as who issued the records, who earned them, how they can be verified, and ultimately how they can be applied to yield a credential/degree.

Building Community and Consensus

The nonprofit Gardner Institute took the lead in convening the UnBlockEd transfer articulation/credit recognition consortium, initially based on institutions within the State of Kentucky (through the Kentucky Council on Postsecondary Education). The goal of this work is to create the policies and structures necessary to launch the UnBlockEd approach using previously collected data from Kentucky during Phase 1 of the project (January–April 2021), so that a pilot project application can be deployed during Phase 2 of the effort (May–September 2021), allowing other institutions to participate. While focused on Kentucky during the first phase of this BIC project, the plan is to ultimately create a consortium involving other regions, possibly starting with a state or region in the Pacific Northwest. Important aspects of this work will include the identification of benefits to the individual colleges and universities involved in the effort, so that education providers come to recognize that there is much more to be gained than lost from giving students agency over their transcript and credit data.

A long-term goal of this project involves identifying and then convening a group of stakeholders (a consortium) to explore how a nonprofit umbrella organization consisting of key stakeholders in higher education will be created in order to provide oversight of the transfer articulation/credit recognition exchange. This will involve defining a broad set of governance principles that will be used to guide the operation of the consortium. The broad mission of consortium will be to offer leadership that allows transfer articulation/credit recognition to reach its full potential. The project team envisions this including other efforts aimed at improving transfer/credit recognition processes. Specifically, because the exchange will serve as an open resource, others may easily incorporate their data into the exchange, and they are free to extract any public (i.e., non-FERPA-protected) data from the exchange. In order to foster this interchange, the project team has worked to develop initial data definitions/dictionaries during the Phase 1 effort, and we are working to more fully vet them by the community during Phase 2 of this project.

Data Literacy and Agency (Student Empowerment)

For the project to be a success, it was not be enough to build the UnBlockEd interoperable blockchain system with the consensus of the institutions and organizations in a consortium. Rather, the approach must be understood and used by students to make decisions about the programs that will help them optimize their credits earned and accelerate time to a quality credential. The system must get data into the hands of learners so they

can exercise agency over their transcripts/credits and share them in a secure, validated, and machine-readable way. The project team is especially focused on using the UnblockEd effort to help students from low-income and/or historically marginalized race-ethnicity groups exert their transcript data agency. To help make this possible, the Gardner Institute worked with partners in Kentucky (and over time other states) to produce and distribute via YouTube and other means short videos that are accessible via mobile devices. These videos explained the benefits of the UnblockEd transfer wallet, and shared directions on how the UnblockEd tools can be used by students to help them identify and apply to the educational institutions that best serve their educational goals in the shortest time—thereby increasing the likelihood of the students completing a high-quality postsecondary credential and addressing equity concerns in the process of doing so.

MVP 1 Work

PROJECT MANAGEMENT

The project involved 15-minute daily standup meetings that were scheduled to make sure all of the members of the project team had the resources they needed for the day (i.e., the team worked to resolve “blockers”). In addition, a weekly one-hour sprint planning meeting was held each Friday to plan the work of the following week. The team leveraged an agile process in all of their work. Modern software engineering practices were employed to develop a code pipeline from version-controlled repositories in Github, to auto-deployed sites on donated AWS infrastructure.

The University of Arizona team included Greg Heileman and a graduate research assistant. The work of these two primarily focused on the overall architecture of the system, integration of the technology components, and ensuring that the curricular analytics capabilities met the needs of the project.

The role of Georgia Tech in the UnblockEd project was focused on development of a front-end for the proof-of-concept web application. The Georgia Tech team also built a user-facing “brochure” website, which provided a high-level project overview and contact information for potential collaborators. The team included two faculty members (Chaouki Abdallah and Lew Lefton), both of whom have significant experience with administration and leading technical teams. The administrative perspective is an important one. In order for UnblockEd to be a success, it will need to be of value not only to students, but also to college and university administrators who will make decisions on whether or not to share course data, degree plans, etc. In order to meet the tight deadlines of this project, Georgia Tech hired two undergraduate students to do design and development. They also provided valuable perspectives as potential users of UnblockEd.

The team from the Gardner Institute included Drew Koch, Brandon Smith, Rob Rodier, and Hayden Free (as a software development contractor).

For the web app front-end, key user stories were used to develop wireframes that articulated basic site navigation, interaction, and look and feel. Georgia Tech students designed with the tool Figma, which allowed easy collection of feedback from others across the larger team. After a couple iterations on the design, an initial application with limited functionality was built using the React framework. A second and more refined

and functional version then followed, which required that the Georgia Tech students collaborate with other members of the team, including Fluree engineers. The final version included live integration with the Fluree distributed ledger and the Curricular Analytics logic engine.

STANDARDS

From the very beginning, the team's priority was to build a solution around open-source, gold-standard specifications and guidelines. The project team sees it as a fundamental necessity that UnBlockEd's platform strives for cost-efficiency, interoperability, and accessibility, and a standards-driven approach is necessary for all three. Although the ecosystem of Verifiable Credentials and Decentralized Identifiers is quickly filling up with closed-source, proprietary software, the team still sees it as imperative that efforts like UnBlockEd remain grounded in the W3C-defined standards, data-formats, and implementation best-practices that undergird it. As such, UnBlockEd's technology is powered by the following open standards:

- W3C VC Spec
- W3C DID Spec
- W3C Universal Interop Wallet Spec
- W3C JSON-LD
- W3C RDF
- W3C CHAPI
- Credential Engine CTDL
- IMS Global CLR

One key differentiator is that the data-layer platform UnBlockEd elected to use is a semantic-standards-based, blockchain-backed database known as Fluree. Unlike other implementations that acknowledge the above standards but ultimately destructure them when they are forced to persist and operationalize data in a legacy data platform, using Fluree allowed UnBlockEd to maintain the richness and capabilities of the above-mentioned standards from end-to-end, extending the value and accessibility of the platform's data in fundamental and necessary ways.

LESSONS LEARNED

Challenge: Important academic institutional data related to degree requirements is often “siloes” within difficult-to-access data systems. This makes it very difficult to integrate with not only a cutting-edge blockchain-enabled solution, but *any* programmatic and automated solution.

Solution: Because the team focused on early, collaborative project-planning, they were able to recognize this challenge out of the gate, and organize resources to begin updating, enriching, and reorganizing access to important institutional data to meet analytics needs and application technology. The team was also able to disambiguate which pieces of this data transformation would have to happen during Phase 1 of the project, and which could be reasonably tackled in the subsequent phases.

Challenge: Transfer data fundamentally requires an idea of data equivalence, but some academic institutions do not maintain rich enough metadata to automatically evaluate suitable equivalences (e.g., a default option often involves accepting prior course work as elective credits, which are often very difficult to apply to degree requirements satisfaction).

Solution: Because the team was built not only around technology providers but with experts in student learning and academic success, they were able to discover and evaluate difficulties like this early in the project and prepare for them accordingly. At this stage in the platform’s development, identifying and understanding a data-related gap is already a success, and the project expects to be able to resolve problems such as this as the platform scales.

Challenge: Even as academic institutions voice a desire for blockchain-enabled technology, they sometimes resist the intended outcome of student-owned data in the form of verifiable credentials.

Solution: For this challenge, the team discovered and pursued both technical and non-technical routes to resolution. The technical team made sure to engage with platform solutions that would still invest control over data to academic institutions (i.e., ways for institutions to surface appropriate data to students and platforms without exposing it entirely or giving up their proprietary control). The non-technical team also engaged in various interviews and focus groups to clarify and extract community-wide wants and needs, ensuring that the platform always aimed to resolve provable, demonstrable problems. It is also important to recognize that this project is “ahead of the curve” with regard to the widespread recognition that students in fact own their learning records. The same resistance occurred within the medical records community and has steadily and rapidly eroded over time. The UnBlockEd team believes the same will happen with student records. When appropriate technology is available that allows students to reliably and securely control and share their learning records, colleges and universities will be compelled (through legislation perhaps) to provide this data to students.

BEST PRACTICES IDENTIFIED

As expected, the use of W3C standards was key to the ability to deliver a solution that would be interoperable and scalable into the future. The use of Verifiable Credentials (VC) and Decentralized Identifiers (DID) constructs in building a basis for trusted collaboration within a blockchain network provides confidence to the solution that the UnBlockEd team built.

One critical and perhaps easily overlooked success was choosing a modern data platform (Fluree) that was itself built on the W3C and blockchain-based standards that are fundamental to Verifiable Credentials. So much of the hurdle this effort needed to overcome was the state of prior data that had been pigeonholed into closed-ecosystem data silos, and which therefore could not satisfy the platform’s needs for interoperability or availability. Without a semantic, blockchain-backed data platform, any of the modern VC or blockchain-based solutions the team might have provided would have also risked simply re-siloing the data into another closed-world environment which, itself, would have failed to achieve scale or interoperability in future efforts.

The team’s use of Credential Engine’s CTDL vocabulary provided assurance to the ACE BIC team and its external stakeholders that UnBlockEd’s transcript articulation solution was ready for open, interoperable standards that would best serve the EdTech community. The UnBlockEd team was very impressed by the CE team’s willingness to understand and extend the CTDL capabilities for academic program requirements, particularly when a use case merited their definition extensions. The team identified that many other solutions in this arena have been/are being built on this vocabulary or extensions of it. The team also engaged with the DXtera organization in order to investigate improving extract-transform-load (ETL) automation which

will be required in order to obtain useful institutional (degree requirements) data on a large scale. This also constitutes one of the largest remaining risks associated with the UnBlockEd project, and therefore one of the most important action items related to the Phase 2 effort; namely, what is the extent to which the extraction of degree requirements data from college-based information systems (typically siloed within rule-based degree audit systems) can be automated?

REFLECTION

The team had prior knowledge of the challenges that would be encountered in building support for this technology solution, but was gratified to learn that both community college administrators and students wholeheartedly agreed with the significant need for improvements related to the efficiency of the transfer process.

Prior to beginning this project, the technical solution—VCs and DIDs were known methods for the facilitation of trusted interaction within a blockchain network. What the team did not know was that the standards around these W3C standards are still very much a work in progress. The team learned that, while there are key elements that can be used presently, the implementation details are often tied to the developer's specific solution—in some cases, specific closed-source software.

The team intentionally stuck with standards in order to be sure that the UnBlockEd solution would be scalable and interoperable with other solutions. This was/is seen as a key. However, the standards are currently in their infancy for VC/DID deployment, so even with this goal, close attention needs to be paid to building abstractions that may change in the future as standards evolve. The team felt they were successful in this, but of course, the future cannot be predicted.

The team is looking to expand the UnBlockEd ecosystem to Arizona and potentially to other state systems (with a Gardner Institute relationship).

COMMUNITY ENGAGEMENT DURING MVP-1

To ensure that the processes and tools developed during the UnBlockEd project meet the needs of individuals within the transfer ecosystem, the team utilized a mixed-methods approach to engage with staff and students in the State of Kentucky. The Council on Postsecondary Education met with us frequently at the beginning of the project. It helped us connect with leadership, specifically Kris Williams, the Chancellor of the Kentucky College and Technical College System (KCTCS). In recent years, KCTCS has regularly served over 100,000 full-time students in the State of Kentucky.¹⁵ As a two-year institution, KCTCS community members have a deep understanding of the current strengths and challenges related to transfer in the state.

The initial engagement approach with the KCTCS community involved sharing a survey with staff and students, followed by focus-group discussions. The purpose was to gather feedback regarding community perceptions and insight linked to the use of blockchain-based transcript technology. In alignment with an ecosystem-first approach, the team also sought their input regarding what design elements and considerations would make the proposed technology and strategies most helpful to them. Before the survey, participants were shown a brief informational video outlining the technology and ecosystem design of the UnBlockEd project

then took a 5–10-minute survey. The UnblockEd team also invited the community to join one of eight optional focus-group sessions, which lasted about one hour each. These Zoom-based sessions were recorded, and excerpts from responses were used to inform design decisions and share participant voices during future presentations about UnblockEd.

Recruitment

Participants were invited to watch an informational video and complete a brief survey. The Chancellor's Office also sent out separate emails asking staff and students to participate in focus group discussions. Focus group sessions included students, faculty, staff, advisors, and registrars. Participation was voluntary, and participants were told they could opt to withdraw from this study at any time by emailing Brandon Smith at smith@jngi.org.

Informational Video

As part of the UnblockEd user education plan, the Gardner team members created a [seven-minute informational video](#) to proceed with surveys and focus group conversations. The video offers a high-level overview of the project that would allow them to respond to questions about how the proposed project might impact their experience within the transfer ecosystem. The video includes sections about problems of practice linked to the current transfer process, how the UnblockEd process could address inequities in the current transfer system, and a basic overview of how the project will provide utility to students, their families, and higher education faculty and staff. The UnblockEd team hopes to leverage learning and the developing relationships forming in this initial engagement process to prioritize future community resource development.

Survey

The survey gathers community perceptions about the UnblockEd project using both Likert-type and open-ended responses. There were 45 individuals who completed the survey: 30 were students and six were advisors, while the rest of the participants chose not to identify a role. The survey was distributed through the Chancellor's Office as part of a newsletter. The Qualtrics-based survey consisted of seven sections: Welcome and Consent, Demographics, Main Question Block, Student Block, Other Users, Registrar Block, and an Advisor Block. All participants completed the Welcome and Consent, Demographics, and the Main Question blocks. The team asked all users to only complete one of the following blocks, based on self-identification of their role: Student, Registrar, Advisor, and Other Users. The survey data was kept confidential and stored in an encrypted, password-protected account. The survey presented minimal risk to subjects, and the team quickly gained approval through the KCTCS Institutional Review Board.

Each survey block contains both open-ended and 5-point Likert-type scale questions. Completion of the survey took most people under 10 minutes to complete, regardless of role.

Focus Groups

There were 41 participants who self-selected to engage in one of eight focus group sessions. In contrast with the surveys, focus group participants were predominately faculty and staff, though there was one focus group session entirely devoted to students.

Like the surveys, subjects consented via a digital waiver and then watched a seven-minute video about the UnBlockEd project. Participants then responded to the following questions during the one-hour session:

- What is your initial reaction to each of the UnBlockEd projects?
 - » What are your reactions to the main strategies of the project?
 - Social Equity and Capital Building
 - The Consortium
 - The Technology
- Do you have any concerns about the use of such technology?
- What will make the adoption of this technology a challenge?
- What about the technology seems most beneficial to you?
- What would the technology have to do for it to be something that would aid your work (staff faculty) or academic progress (students)?
- Have you ever transferred? If so, what can you share about that process? Did your credit transfer as expected?
- How should we share information with the larger community about this project?
- What else should we be considering as we continue to develop this technology?

Survey and Focus Group Responses

Of the 45 survey responses, the majority of participants were students. About two-thirds of survey respondents identified as White. The second-largest demographic group identified as Black or African American, and the third largest identified as Hispanic or Latin(x). It is also worth noting that over half of participating students identified themselves as recipients of federal financial aid in the form of grants (such as Pell grants).

When asked if they would utilize blockchain-based transcript technology if made available, 78% of participants stated they would be either highly likely or somewhat likely to use the technology. About 75% of respondents believed that the digital transcripts technology outlined in the UnBlockEd process would empower students, help with degree completion, and improve the transfer process. About two-thirds of respondents believed that the process would reduce lost credit. The majority of students who participated in the survey said they had transferred in the past, and of the group, more than half stated that their credits did not transfer as expected.

In the open response sections of the survey, participants identified concerns about the teaching and learning associated with a shift in use of new tools, both for students and staff. In short, offering the technology will not be sufficient; there will be a need to provide training, oversight, and support for institutions and students

during the initial stages of this project. This sentiment was strongly echoed by those who participated in the focus group sessions. The feedback provided offers insight into the importance of the Consortium model outlined in this project.

There were 41 participants who self-selected to engage in one of eight focus group sessions. As mentioned earlier, in contrast to the surveys, focus group participants were predominately institutional employees. There were a wide range of participants during the focus group sessions, including faculty, leadership, registrars, advisors, employees within the systems office, and students. Overall, there was an overwhelmingly positive response from focus group participants. Many noted the potential for streamlining processes, reducing and automating work, and the potential to spend more time with students focusing on advising rather than procedural work. That said, there were concerns about the workload, training, and maintenance of such an undertaking. More than one employee voiced exhaustion and fear that they might not see the level of organizational commitment required to realize such an effort. Both the students and staff who were surveyed stated that the realization of such a project offers the potential to improve outcomes for historically minoritized student populations, reduce costs, improve graduation rates, reduce time to graduation, and essentially revolutionize the entire transfer system.

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The Education Blockchain Initiative: Final Report

APPENDIX E

North Texas Collaborative



North Texas Collaborative

Executive Summary

In North Texas, the educational attainment, median household income, and income poverty rate gap between the population identified as White, and the population identified as Black and Latino/Hispanic is notable. The educational attainment gap between these groups, for example, grows along with the years of education achieved. The ACE Blockchain Innovation Challenge-North Texas Initiative (BIC-NT), led by Texas Woman's University in collaboration with GreenLight Credentials, the Carrollton-Farmers Branch Independent School District, the North Central Texas College, Texas A&M University-Commerce, and The University of Texas at Arlington, is a vital step to improving the economic mobility of underserved students and job seekers in the Dallas-Fort Worth Metroplex.

In the spring of 2021 and depending on their individual outreach strategies, members of the consortium deployed a proven blockchain digital credentials platform to their students. The expectation is that this platform will empower students to store and share their education credentials, transcripts, industry certifications and badges with employers and postsecondary institutions for employment and educational opportunities.

GOAL

The overarching goal of the BIC-NT initiative is to narrow the college graduation and the employment gap of underserved populations in North Texas. The BIC-NT partners will approach this goal by increasing the number of students who have free access and control of their academic records. By increasing this pool, they also expect to increase the number of students who share their academic records with academic institutions and employers and receive employment that will help them achieve a better life.

METHODOLOGY

Ecosystem-First Approach & Ecosystem Building

The educational institutions coming together as a part of this initiative see blockchain as a potential solution to empower their students to improve economic mobility. By giving students the opportunity to control their records in GreenLight, it opens up myriad possibilities for those records to be used to advance their educational and professional careers. The ecosystem seamlessly connects ISDs, community colleges, postsecondary institutions, and employers to allow users access to more opportunities.

A markedly better way of thinking about digital credentials and their contextual data is necessary to remove some of the challenges associated with economic mobility, like standardization, control, and data. There is almost complete agreement that changes are needed, but their adoption will take time. This calls for a hybrid approach that allows institutions to comfortably and safely migrate to the new paradigms. GreenLight's solution provides the platform to realize this transition.

The GreenLight platform is a robust and highly available verified educational records platform that has been scaled to nearly 2,000,000 records. It has operated with no downtime or interruption of service for over 2

years. GreenLight is a SAAS application on the AWS Cloud which is 99.95% available and is geo-redundant in an Active-Active Infrastructure. Each Institution can run its own Blockchain peer node or allow GreenLight to run and operate the node on their behalf. In addition, GreenLight also participates in permissioned public blockchain networks such as Sovrin and soon, the Velocity Network. GreenLight provides both Web and API interfaces for Institutions to interact with GreenLight and run analytics such as Student Activity reports on an on-demand basis.

Interoperability

GreenLight, as a verified repository of digital credentials, is laser focused on verification and authenticity. The platform provides a high-integrity approach to receiving academic records directly from an educational partner. It has the ability to integrate with SIS systems, Ed-fi ODS, or accept PESC XML, EDI or csv files. GreenLight also has the ability to generate viewable transcripts from the underlying data using standard transcript formats. Although at different levels of progress, GreenLight and each BIC-NT educational partner collaborated to test the transcripts shared, validate data and obtain final approval. Following validation of sample data, each educational partner configured its data feed for demographic data, hold information, and transcript data for all students. Once the platform becomes operational, educational partners start communicating with high school and college students, and parents of students under the age of 18, to prepare them to sign-up and claim their digital credentials. The platform also supports current verifiable academic records anchored to the blockchain, while offering institutions a pathway to provide complete control to students in the long run.

Social Equity

Social equity and economic mobility are the driving mission for the BIC-NT initiative, as this innovative process empowers high school and college-going students the opportunity to take control and ownership of their academic records. This opens myriad possibilities for students to advance their educational and professional careers. The student populations that this ecosystem serves are diverse. Through individual and collaborative engagement strategies, the BIC-NT partners aim to address financial barriers associated with multiple transcript acquisition by providing them free access and control of their credentials; address the fear of “technology and data security” to gain access to academic records that can be included in the students’ GreenLight Locker with face-to-face/virtual demonstration sessions; and promote timely access to records for students who often work outside the classroom on non-traditional schedules to access information.

User Education and Recruitment Plan

Outreach to students to increase social equity and economic mobility are vital. Partner institutions are connecting with students and parents of minors through a myriad of communication tools and platforms. Consortium partners’ education and recruitment plans include training staff; utilizing existing student and parent engagement technological platforms (e.g., TEAMS Parents Self Serve, Pioneer Portal, MyLeo, MyNCTC, MyMav); adding GreenLight informational videos to Registrar, Admission and other websites; sending text messages and blast emails to all students or targeted student groups; maintaining Instagram communication and competitions.

CHALLENGES, LESSONS LEARNED, AND BEST PRACTICES

Since Phase 1 of the BIC-NT initiative focused on establishing interoperability, the lessons learned and best practices are related to this goal. These include:

- Improve communication on architecture fit and full scope of project
 - » Partners benefit from kick-off discussions to understand the IT requirements, specifically around file format to review system capabilities and plan for delivery.
- Allow for a planning period and contingencies
 - » Partners' IT teams benefit from having a planning period to schedule work and capacity, prepare for requirements, identify and assign resources, clean up data, as well as to include assessment strategies.
- Explore alternative approaches to data delivery
 - » Partners benefit from having IT and student records administration teams involved in providing input on solution delivery. This allows for discussions on alternative approaches to data delivery (i.e., transcripts on demand) and for more efficiency in system resource usage.
- Allow for administrative training early on
 - » Partners benefit from engaging student records administration, career services and advising staff in GreenLight training related to customer usage of the GreenLight Locker. Piloting the service via trials and focus groups with students before deployment can help identify possible troubleshooting needs.

FUTURE PLANS

BIC-NT Initiative future plans include extending its ecosystem to additional vectors. They also include expanding its ecosystem with alumni, school districts from Cooke and Montague Counties, and Graham ISD to provide them access to GreenLight Credentials services, and with local employers, workforce agencies, and social services agencies. Finally, plans include designing, seeking funding and reporting findings of a mix-methods research study that assesses the impact of the initiative in the student population.

Final Report

OVERVIEW OF THE PILOT

In North Texas, the educational attainment, median household income, and income poverty rate gap between the population identified as White, and the population identified as Black and Latino/Hispanic is notable. The educational attainment gap between these groups, for example, grows along with the years of education achieved.¹ The ACE Blockchain Innovation Challenge-North Texas (BIC-NT) is a vital step to improving the economic mobility of underserved students and job seekers in Denton, Texas, as well as within the Dallas-Fort Worth Metroplex. Texas Woman's University, along with its North Texas partners, have been focused on improving the economic mobility challenge for years. This consortium of institutions and technology partners is uniquely qualified to launch a blockchain-secured economic mobility platform to this geographic area. This consortium includes:

- Texas Woman's University
- The University of Texas at Arlington
- Texas A&M University-Commerce
- North Central Texas College
- Carrollton-Farmers Branch Independent School District

In the spring of 2021 and depending on their individual outreach strategies, members of the consortium deployed a proven blockchain digital credentials platform to their students. The expectation is that this platform will empower students to store and share their education credentials, transcripts, industry certifications, and badges with employers and postsecondary institutions for employment and educational opportunities.

PARTNERS

Texas Woman's University

Texas Woman's University (TWU) is the nation's largest public university primarily for women with almost 16,000 students at its three locations in Denton, Dallas, and Houston. Texas Woman's is known for its contributions and leadership in the fields of education, nutrition, business, the arts and sciences, and especially in the nursing and health care professions. Texas Woman's University creates value from multiple perspectives. It benefits state businesses by increasing consumer spending in the state and supplying a steady flow of qualified, trained workers to the workforce. TWU also enriches the lives of students by raising their lifetime earnings and helping them achieve their individual potential. Finally, Texas Woman's benefits society as a whole in Texas by creating a more prosperous economy and generating a variety of savings through the improved lifestyles of students.

1 Wiedrich, K., Sims, L., & Assante-Muhammad, D. (2019). *Assets, Opportunity, and the Racial Wealth Divide in Dallas*. Prosperity Now. <https://www.cftexas.org/cft/files/03/03112914-5496-4775-9c9e-182327ea0efd.pdf>

The University of Texas at Arlington

The University of Texas at Arlington (UTA), designated as a Research 1: Doctoral University—Very High Research Activity, is the largest university in North Texas. Its more than 60,000 students come from every state and more than 100 countries, resulting in one of the most diverse campus populations in the nation. UTA is proud of its designation as a Hispanic-Serving Institution, its recognition by educational nonprofit ScholarShot as number one (tied) in Texas for serving first-generation, low-income students, and its ranking (#26) in *U.S. News & World Report's* 2021 list of the “Top Performers on Social Mobility” among national universities. UTA Maverick spirit is reflected in its culture of continuous improvement and innovation coupled with a relentless student-centric focus which has enabled rapid implementation of cutting-edge services.

Texas A&M University-Commerce

Texas A&M University-Commerce (TAMUC) is the third largest campus in the Texas A&M University System, serving nearly 13,000 students on its five campuses and online. It is the leader in Texas in competency-based education, providing the opportunity to nearly 1,000 Texans each year to complete their baccalaureate degree and increase their career opportunities.

North Central Texas College

North Central Texas College (NCTC) serves nearly 10,000 students in North Texas. NCTC is qualified to participate in this initiative because they focus on developing stimulating learning environments that can empower their students to impact a global society as creative problem solvers, critical thinkers, and dynamic leaders. They do this through exceptional staff and leadership, but also through a campus-wide embrace of innovative, challenging, and creative ideas to help their students succeed.

The Carrollton-Farmers Branch Independent School District

The Carrollton-Farmers Branch Independent School District (CFBISD), a diverse community of more than 25,000 global learners in 38 campuses, is dedicated to empower scholars to acquire lifelong knowledge, skills, and values that prepare them to compete in the world marketplace while contributing to their community. Its 4-year graduation rate of 94.8% stands above the Texas average.

GreenLight Credentials

The GreenLight Credentials (GreenLight) platform is the world's largest education blockchain platform storing over 2 million user records. GreenLight is used by several major Texas academic institutions, such as the Texas Education Agency, ISDs (e.g., Dallas ISD, Mesquite ISD, Garland ISD, Grand Prairie ISD), community colleges such as Dallas College, and four-year colleges, for example the University of North Texas, as well as Dallas Promise, P-Tech, and large employers to transform the college application process and to match talent with employer needs. In just 12 months, over 60,000 Texas students have used GreenLight to successfully share their records with over 1,000 colleges and hundreds of employers nationwide. This number is growing quickly. GreenLight is proud of the support from the Communities Foundation of Texas and the Michael and Susan Dell Foundation.

GOAL AND OUTCOME MEASURES

Goal

The overarching goal of the BIC-NT initiative is to narrow the college graduation and the employment gap of underserved populations in North Texas. The BIC-NT partners will approach this goal by increasing the number of students who have free access and control of their academic records. By increasing this pool, they also expect to increase the number of students who share their academic records with academic institutions and employers and receive employment that will help them achieve a better life.

Outcome Measures

The success of this initiative will be measured by short, mid,- and long-term outcomes.

Short-term outcomes:

- Number of students with blockchain-secured lockers for their academic records
- Number of students who have shared their academic records, and how often
- Number of employers who receive records

Mid-term outcomes:

- Increase in the number of students admitted to undergraduate and graduate programs
- Increase in the number of students awarded academic scholarships
- Increase in the number of graduates who secure employment in their chosen area

Long-term outcome:

- Narrowing of the graduation and employment gap of underserved populations

METHODOLOGY

Ecosystem-First Approach & Ecosystem Building

The educational institutions coming together as a part of this initiative see blockchain as a potential solution to empower their students to improve economic mobility. Giving students the opportunity to control their records opens up myriad possibilities for those records to be used to advance their educational and professional careers. The ecosystem seamlessly connects independent school districts (ISDs), community colleges, postsecondary institutions, and employers to allow users access to more opportunities.

A markedly better way of thinking about digital credentials and their contextual data is necessary to remove some of the challenges associated with economic mobility, like standardization, control, and data. There is almost complete agreement that changes are needed, but their adoption will take time. This calls for a hybrid approach that allows institutions to comfortably and safely migrate to the new paradigms.

Standards, such as the Comprehensive Learner Record (CLR), provide the ability for the one dimensional academic transcripts, badges, and certifications to be transformed into multi-dimensional records through the inclusion of non-classroom achievements, military and work records, activities such as volunteer work, apprenticeship and internship experiences, etc. The current ability for independent verification of such achievements through digitally signed assertions provides the needed trust in such documents to make them valuable.

Students can dynamically create their learner records from other types of academic records such as the traditional transcripts, open badges, certificates, certifications, recommendation letters, evidence of projects, etc. As standards and technologies such as W3C Verifiable Credentials, Decentralized Identifiers (DID), Decentralized Public Key Infrastructure (DPKI) through blockchain networks such as Sovrin or Velocity become widely adopted, institutions will become issuers and verifiers of data. Learners will benefit from the ability to receive verifiable credentials from any source of lifelong learning and own it for posterity.

GreenLight, the platform that the consortium uses, is a robust and highly available verified educational records platform that has been scaled to nearly 2,000,000 records. It has operated with no downtime or interruption of service for over 2 years. GreenLight is a SAAS application on the AWS Cloud, which is 99.95% available and is geo-redundant in an Active-Active Infrastructure. Each institution can run its own Blockchain peer node or allow GreenLight to run and operate the node on their behalf. In addition, GreenLight also participates in permissioned public blockchain networks such as Sovrin and soon, the Velocity Network. GreenLight provides both Web and API interfaces for institutions to interact with GreenLight and run analytics such as Student Activity reports on an on-demand basis.

The GreenLight platform, with its extended digital credentials into additional vectors, allows students to be matched to scholarships, educational opportunities, and employment opportunities. The BIC-NT initiative is considering these vectors:

- **Scholarship Matching:** Students who opt-in have the opportunity of being matched to over 1,000 scholarship providers with more being added. The platform presents students with scholarships for which they meet the eligibility criteria, based on verified data available in GreenLight, and supplemented by additional data from the students. Students can learn more about the scholarship and then go to the scholarship provider's website to apply directly.
- **Educational Marketplace:** Students who opt-in have the opportunity of being matched to educational opportunities. Postsecondary institutions can filter those prospective students by relevant demographics such as graduation date, academic coursework and achievements, standardized test scores, extracurricular activities, and more. The BIC-NT institutions can then contact those students and offer them more information about the institution, financial aid information, or other critical information that may assist in recruiting the student.
- **Employment Marketplace:** Students who opt-in also have the opportunity of being matched to employment opportunities. Employers can post employment opportunities, and define specific criteria for a position, including minimum GPA, degree requirements, and job location. The platform can match all prospective job seekers to this job posting and alert the job seeker of the match. The

job seeker can then share verified information such as transcripts, and unverified information such as cover letters and resumes directly. This helps employers fill jobs with qualified candidates in days rather than months and job seekers find employment more quickly.

- **Content Marketplace:** Students who opt-in have the opportunity of being matched with education and training opportunities to learn new skills or enhance their current skills. For example, GreenLight Credentials' Content Marketplace is the hub of the Texas College Bridge (TCB) program (<https://texascollgebridge.org/>). Through this program, 350,000 Texas seniors have single sign-in access to college-preparatory courses based on their specific needs.

Interoperability

Two of the BIC-NT partners' priorities were ensuring the authenticity of their students' credentials and making the systems of all partners interoperable. To address these priorities, BIC-NT selected GreenLight, a verified repository of digital credentials that is laser focused on verification and authenticity. The platform provides a high-integrity approach to receiving academic records directly from an educational partner. It has the ability to integrate with SIS systems, Ed-fi ODS, or accept PESC XML, EDI or csv files. GreenLight also has the ability to generate viewable transcripts from the underlying data using standard transcript formats. Although at different levels of progress, GreenLight and each BIC-NT educational partner collaborated to test the transcripts shared, validate data and obtain final approval. Following validation of sample data, each educational partner configured its data feed for demographic data, hold information, and transcript data for all students.

Once the platform became operational, educational partners started communicating with high school and college students, and parents of students under the age of 18, to prepare them to sign-up and claim their digital credentials. These simple steps were all that was necessary for students to take control of their credentials and be matched with relevant opportunities. GreenLight does not force any particular standard on its customers and is able to convert data from one standard to another. The platform also supports current verifiable academic records anchored to the blockchain, while offering institutions a pathway to provide complete control to students in the end.

Social Equity

Social equity and economic mobility are the driving mission for the BIC-NT initiative, as this innovative process empowers high school and college-going students the opportunity to take control and ownership of their academic records. This opens myriad possibilities for students to advance their educational and professional careers. The student populations that this ecosystem serves are diverse. The combined population of nearly 120,000 students is representative of the diverse North Texas community, with race/ethnicity distribution noted as approximately 33% White and 32% Hispanic. Black/African American at 15% and Asian at 9% round out the next two largest races for students. Notably, there is also geographic diversity amid these students: NCTC and TAMUC serve rural students, and all of the education partners inclusive of CFBISD, NCTC, TWU, TAMUC and UTA serve suburban students. This expansion and continuation of services from the more urban students Dallas College serves, helps the consortium reach additional students to increase social equity and economic mobility for rural, suburban, and urban students.

The inclusion of an ISD (high school diploma), a community college (non-credit certificates, industry-recognized certifications, badges, credit Level 1 workforce certificates, and associate degrees), and universities (awarding bachelor's, master's, and doctoral degrees and certificates) allows the BIC-NT initiative to offer multi-layers of credentials. This depth of education provides underserved students with an educational path to build their confidence and be successful in a “college-going culture.”

Impacting at-risk students is a daily endeavor when 45% of the collaborative student population is identified as underserved. Through individual and collaborative engagement strategies, the BIC-NT partners aim to address financial barriers associated with multiple transcript acquisition. It does this by providing students with free access and control of their credentials while they are students in each institution and one year after that; addressing the fear of “technology and data security” to gain access to academic records that can be included in the students’ GreenLight Locker with face-to-face/virtual demonstration sessions; and promoting timely access to records for students who often work outside the classroom on non-traditional schedules to access information. These student engagements will bring to life the concept of being available to students when and where they need information.

User Education and Recruitment Plan

Outreach to students to increase social equity and economic mobility are vital. Partner institutions are connecting with students and parents of minors through a myriad of communication tools and platforms. Consortium partners’ education and recruitment plans include training staff; utilizing existing student and parent engagement technological platforms (e.g., TEAMS Parents Self Serve, Pioneer Portal, MyLeo, MyNCTC, MyMav); adding GreenLight informational videos to Registrar, Admission, and other websites; sending text messages and blast emails to all students or targeted student groups; and maintaining Instagram communication and competitions.

TECHNOLOGY APPROACH

Standards

The blockchain component of the solution is GreenLight Credentials. GreenLight is a proven, scaled digital credentials platform with over 1.8M verified learner records. This makes GreenLight the largest

SHOWCASE: NCTC EDUCATIONAL AND RECRUITMENT ACTIVITIES

While other partners decided to reach all students at once, NCTC’s strategy consisted in stratifying student and creating an outreach schedule:

Group 1- Pell Grant eligible students

Group 2- Students graduating in 2020-2021 academic year

Group 3- All career and technical education students

Group 4- All existing students in the spring term of 2021

Moving forward, the goal is to have all students registered in GreenLight by the census date of each semester.

NCTC also promoted the credential services via affinity group outreach and education by holding small group discussions and demonstrations of GreenLight lockers with adult learners, ethnic minority students, students with food and housing insecurity and in foster care, GED students, LGBTQ+ students, rural communities, veteran and military students, and women and minority students in STEM programs.

verified repository of learner records that is verified by blockchain. The technical component of its execution is to deploy GreenLight to educational partners in the BIC-NT initiative. This implementation brings verified records from the educational institutions into GreenLight. These verified records can then be controlled by students and shared with educational institutions, employers, scholarship providers, and others.

GreenLight does not force any particular standard on its partners, as it is able to convert data from one standard to another, which means it can easily receive verifiable records based on legacy as well as newer standards. GreenLight's vision, delivered via its hybrid architecture, supports current verifiable academic records anchored to the blockchain, while offering institutions a pathway to provide complete control to students in the end. Its platform is built on the IBM HyperLedger blockchain infrastructure and allows any type of credential shared to be instantly verified. A focus on open platforms and interoperability gives GreenLight greater flexibility than other solutions in use today.

The GreenLight solution allows students in BIC-NT partner institutions to control their lifelong learning credentials using the GreenLight mobile wallet or the web application. K–12 and postsecondary education institutions can issue academic credentials such as verified transcripts, badges, certificates/certifications, and CLRs to their students. Students can control and share these records with anyone at any time.

GreenLight has several methods of integration for educational institutions to issue verifiable credentials. The integrations range from a full scope SIS integration to a simple CSV-based integration. It can also use TS 130 EDI or PESC XML data for the integration. Once a method of integration is chosen, the next step is to establish bi-directional secure data feeds.

GreenLight can generate transcripts for K–12, community colleges, and higher educational institutions using data sent by the issuing institution. GreenLight's open platform permits further enrichment of a student's transcript with skills and competency information through add-ons such as:

- **Credential Engine:** Eligible organizations can enrich transcripts with skills and competency information through the use of JSON Linked Data from CTDL. Moreover, students can query the GreenLight Platform Service to identify content and credentialing providers to be job-ready.
- **Concentric Sky's Badgr Platform:** Eligible organizations can offer alternative ways of recognizing a student's accomplishments around chosen career pathways to store their student records and integrate with traditional transcripts. Employers now will find it easier to match with students that best fit their needs.
- **BrightHive:** Local, state, and federal agencies will have better insights to depersonalized data to improve on policymaking and track effectiveness of policies in place.
- **IMS Global:** GreenLight's partnership with IMS Global ensures that both parties are able to test and improve on the CLRs design and adoption.
- **Velocity Network:** Where students can monetize their records and have wider visibility of their skills to employers and recruiters.
- **NextTier:** High school counselors, students, and parents receive guidance, information, and insight to seamlessly align digital credentials with students' postsecondary goals.

Students can also generate CLRs by adding their various achievements, each of which is digitally signed and independently verifiable through the public or private keys of the issuing institution or organization. GreenLight can also retrieve work-related credentials from employers through integrations with their Talent Management Systems.

When a student requests sharing their academic credentials with a third party such as an academic institution or employer, GreenLight translates the student transcripts into a format acceptable for the receiver (any receiver with an email address). For example, GreenLight can generate EDI and SPEEDE Xpress transcripts for delivery through the NSC SPEEDE network. GreenLight can also deliver PESC XML-based transcripts through the SPEEDE network or dedicated sFTP gateways. Institutions can award achievements to students in their GreenLight Locker.

Similarly, receivers can receive the academic credentials through the methods they currently use such as the SPEEDE network or sFTP or through secure dashboards. Receivers who adopt emerging standards such as W3C verifiable credentials can receive the credentials directly from the GreenLight mobile wallet through its integration with the Velocity network and/or Sovrin. GreenLight provides technical assistance to the issuing institutions and employers who want to adopt W3C verifiable credentials to establish their DID (Decentralized Identifiers) on the Velocity network and/or the Sovrin network. GreenLight also provided technical assistance on the know-your-customer (KYC) methods to establish verifiable identity credentials for wallet users. For institutions and employers that would like to begin accepting W3C verifiable credentials, GreenLight can provide assistance with establishing the inspection services for credential validators. It can help institutions set up revocation lists if needed. Based on express student consent, GreenLight has additional options such as scholarship matching, college matching, and job matching.

GreenLight uses the information in the student academic profile and artificial intelligence (AI) to match students to opportunities. It also has extensive reporting and analytics available to each participant with data such as visibility into student career and economic mobility measurements.

The implementation process for credential-sharing between BIC-NT partners and GreenLight included these steps:

1. GreenLight met with the participating organization's technology team.
2. The participating organization's technology team then provided GreenLight with demographic data and transcript data for a small population of students, and with official signature and seal files for the current transcripts to GreenLight.
3. GreenLight loaded and generated a generic transcript format for review and sign-off from the participating organization.
4. Once validated, BIC-NT institutions worked with GreenLight to communicate with students, and parents of students under the age of 18, about the benefits of GreenLight.
5. The partners also delivered the complete demographic and transcript data to GreenLight. GreenLight loaded the complete student data sets into the platform.

6. GreenLight and the participating organization set up periodic data updates to GreenLight to ensure students have up-to-date data available to them.
7. GreenLight and the participating organizations reached out to students to give them information on how to create an account, share their transcripts, and accelerate their opportunities.

Commonly, this entire process takes about three months and requires about 50 hours of time from the participating organization, assuming that the data is submitted in the GLC specified format. GreenLight invests about 150 hours to onboard the participating organization.

CHALLENGES, LESSONS LEARNED, AND BEST PRACTICES

Since Phase 1 of the BIC-NT initiative focused on establishing interoperability, the lessons learned and best practices are related to this goal. These include:

Improve communication on architecture fit and full scope of project

Partners benefit from kick-off discussions to understand the IT requirements, specifically around file format to review system capabilities and plan for delivery. For example, institutions did not have system processes in place to generate transcripts via EDI. To make the timeline for test data, institutions used the existing transcript service provider to generate samples in EDI. They also engaged in conversations with other school districts/colleges doing EDI transmission to understand the process and find out if their IT teams could leverage their knowledge to generate transcripts in EDI. When this strategy did not work, institutions went back to developing transcript files in .csv method. This action required creating 16 types of files, which represented significant efforts for IT teams. Technical teams reallocated resources and adjusted priorities to make that possible.

Allow for a planning period and contingencies

Partners' IT teams benefit from having a planning period to schedule work and capacity, prepare for requirements, identify and assign resources, clean up data, as well as to include assessment strategies. For example, the announcement of the award kicked off the technical tasks' delivery, which required IT teams to do a catch-up and manage system challenges related to volume constraint to generate transcript records of all students at one time. Overall, the timeline for completion of technical work was aggressive. Additionally, natural calamities of extended freezing conditions in the region had the IT teams work on other high priority problems to meet operational needs. However, the challenges were overcome and most IT teams met the established dates.

Explore alternative approaches to data delivery

Partners benefit from having IT and student records administration teams involved in providing input on solution delivery. This allows for discussions on alternative approaches to data delivery (i.e., transcripts on demand) and for more efficiency in system resource usage.

Allow for administrative training early on

Partners benefit from engaging student records administration, career services, and advising staff in GreenLight training related to customer usage of the GreenLight Locker. Piloting the service via trials and focus groups with students before deployment can help identify possible troubleshooting needs.

IMPACT

In most BIC-NT academic partners, GreenLight Lockers were deployed in May of 2021. Impact data by the end of August of the same year and testimonies are shown below.

Table 1: Students with GL Locker and Students Who Have Requested Transcripts by Demographic

	STUDENTS WITH GL LOCKER	STUDENTS WHO REQUESTED TRANSCRIPTS
Race or Ethnicity		
Native Hawaiian or Other Pacific Islander	0	0
American Indian or Alaska Native	24	13
Race and ethnicity unknown	49	54
Two or more races	43	20
Asian	122	52
Black or African American	177	118
White	556	299
Hispanics of any race	250	151
International students	26	29
Gender		
Female	877	526
Male	242	119
Pell Grant recipients or eligible	336	268
Total Students	1119	907*

Note: With this new service, students' cumulative savings was \$5,735.

*There are students who requested more than one transcript.

Testimonies

“I truly enjoyed learning about GreenLight. It was a very easy process – even a toddler could do it. The signup was simple and the steps to send and download my transcript were super easy.”

-Branisha, student

“GreenLight is simple to use. It took just a few minutes to get logged in and see my NCTC transcript. I was able to view my transcript instantly and could even email it to another institution if I needed to. I attended another college (Dallas Community College, now Dallas College) years ago and was able to add that institution to my existing credentials with no trouble. I believe having all this information available in one centralized area will be very useful for me and other students.”

-Michelle, student and employee

Plans

BIC-NT Initiative future plans include:

- Extending its ecosystem to additional vectors, such as scholarship matching, education market, and employment market at the college level.
- Through the Greater Texas Foundation Rural Promise in a Box Grant, expanding its ecosystem with school districts from Cooke and Montague Counties and Graham ISD to provide them access to GreenLight Credentials services.
- Expanding the ecosystem to local employers, workforce agencies, and social services agencies.
- Integrating alumni to the service.
- Designing, seeking funding, and reporting findings of a mixed-methods research study that assesses the impact of the initiative in the student population.

Use Cases

Scenario 1

Let us consider a typical transcript request scenario. A student—let’s call her Maria—is a recent high school graduate who attended a community college enrolled in dual credit courses while in high school where she received her associate of arts degree. Maria decides to transfer to a local university to complete her bachelor’s degree. Maria has applied to the university and submitted her official transcript from the community college to the university’s Admissions Office. Maria has an appointment with her academic advisor this afternoon to discuss which courses she needs to enroll in, and if there are any scholarships for which she is eligible.

When Maria arrives to campus to meet with her academic advisor, she is informed that the transcript has not been received by the Admissions Office. Maria can request that the community college send the university another official transcript, but it will take two to three days for it to be received. Maria remembers that her community college gave her access to an online transcript locker, which allows her to send official transcripts

electronically at any time and at no cost to her. Maria's high school and previous community college integrated the GreenLight platform to their student services.

Maria logged into GreenLight and shared her official college transcript with the academic advisor, who immediately received it through their email account. The academic advisor was able to download and review Maria's official college transcript to determine which classes she needed to enroll in to complete her bachelor's degree. During their advising session, the academic advisor recommended that Maria apply for some scholarships that she was eligible for based on her ranking in high school as well as her college grade point average (GPA). Maria was able to share her official high school and college transcripts with the scholarship committees using GreenLight Locker.

Scenario 2

A student—let's call him Daniel—is a high school senior who has been attending a community college while in high school. He is the oldest of four children to a single mom, and money is tight for this family. Daniel is a straight-A student and is in the top 10 percent of his graduating class. He would like to attend a university to get his bachelor's degree in nursing so he can help support his family. Daniel attended a college fair and visited with several universities that offer his intended major and seem to be a good fit. Daniel met with his high school counselor to discuss applying to universities and for scholarships. He was hesitant to pursue his dreams because of his family's financial limitations. Daniel would not be able to afford to pay for his college transcript to be sent to multiple universities. Daniel's high school counselor reminded him that the high school and community college utilize GreenLight, which allows students to share their official transcript electronically for free. Daniel was able to apply to multiple universities and share his official high school and college transcripts electronically at no charge. He also applied for many scholarships that would require official transcripts at no cost to him. Daniel estimates that the opportunity to own and distribute his credentials has saved him around \$200.

This access to GreenLight allowed Daniel to apply to multiple schools, which gave him options when it came to selecting a university. He was able to see which school offered the most financial aid and scholarships to help him achieve his educational goals. Without access to GreenLight, Daniel would have to submit a transcript request online that could take three to five days to be processed and would cost \$10 per transcript requested. Daniel is also planning to use his credential locker to apply to a part-time job off campus and to request an internship opportunity in the health sector that will allow him to start building his résumé.

