A FRAMEWORK FOR MANAGING STUDENT DATA THROUGH BLOCKCHAIN

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Abstract. According to a recent report by the European Commission, blockchain technologies may "*disrupt institutional norms in the field of education and empower learners*" in line with the needs of Industry 4.0. The Commission proposes eight scenarios for the application of distributed ledger technology (DLT) in an educational context, based on the current state of technology development. This paper looks into the theoretical and practical opportunities for OS.UNIVERSITY as a pioneering initiative in the field to be of benefit to the national "Careers Registration" project in the U.K. higher education system for collection and analysis of student career-planning data. OS.UNIVERSITY aims to create a distributed platform on the blockchain that turns the potentially disruptive DLT scenarios into real-life opportunities for modernization of Academia, enablement of businesses, and empowerment of learners.

Keywords: blockchain, education, edtech, open source technology, universities, career development, careers registration

1. Introduction

According to a recent research by EY (2017), not the lack of information, but rather its inefficient exchange is behind skills' demand and supply mismatch that is harming the process of school-to-job transition. In the example of the national "Careers Registration" (CR) project in the U.K., what the universities do is to measure "career readiness", i.e. to establish, track, and analyze where, how and when students make their career decisions and choices whilst at university (Dray; Ives, 2018). While this is an important step in the right direction (traditionally institutions have been tracking students' academic progress, but not their career development), what happens after the data analysis is what is important for the stakeholders in order to achieve a systemic change together.

By analyzing best practices from the national CR conference "*Insight for employability: The implementation and impact of Careers Registration*" (University of London, 2018), the authors of the current research aim to prove that the role of the students as owners of their own data is underutilized and to propose a framework for exchange of the actual career data through a peer-to-peer blockchain-based system.

A recent report by EU's Joint Research Center (JRC, 2017) includes case studies of blockchain implementations in education from various players. Despite that each of these implementations is still in a piloting phase, the Center concludes: "*It is possible to suggest that blockchain in line with the principles of sharing and transparency of data has the potential to disrupt the information systems market in education by loosening the control that current players have and by empowering learners*."

Within the case of the OS.UNIVERSITY platform that is in the focus of the current research, three sets of "*smart contracts*" are being deployed on the distributed Ethereum blockchain as a method to improve the information-coordination relationships among the various stakeholders in the field of learning and development, instead of relying on centralized systems, closed behind institutional borders. According to the definition, provided by "Investopedia", smart contracts are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. The code and the agreements contained therein exist across a distributed, decentralized network. Beyond cryptocurrencies – the classical blockchain use-case, any number of parties can execute a smart contract that is associated with the registration and transfer of value between them, e.g. property rights, intellectual property, physical assets (Daskalov, 2018).

Figure 2. highlights the end-to-end logic behind one of the information-coordination/exchange processes – the validation and verification of learners' credentials, enabled by a set of L2A (learner-to-academia) smart contracts.

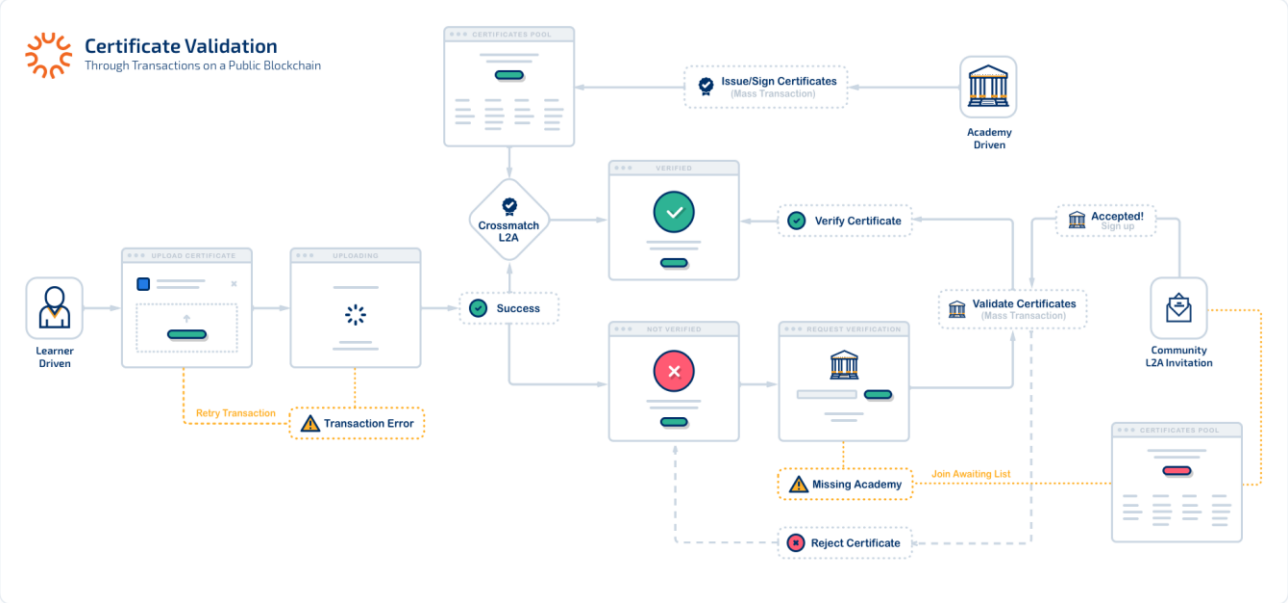


Figure 1. OS.UNIVERSITY L2A process flowchart.

Beyond L2A contracts, L2B & B2A smart contracts are also deployed on the blockchain, because the blockchain as a DLT (distributed ledger technology) system enhances the transactions of information by offering: authenticity; decentralized trust; less bureaucracy; direct interaction; security (Jambazov, 2017).

2. Careers Registration Data

With at least 34% of UK Higher Education providers involved in the growth of the pilot project to investigate the use of "Careers Registration" as a measure of learning gain in relation to work readiness (Cobb, 2018), the application and the impact of the framework as an evidence-based approach for employability support in higher education, continues to gain momentum (*see Table 1*).

Table 1. Careers Registration in numbers

What is it?	What are the questions?	Who is involved?
2–4 careers focused questions added to compulsory student registration and re-enrolment to track progress in career thinking and employability.	2 areas of research interest: - Self-reported "career readiness" (Decide > Plan > Compete> Sorted); - Useful experience gained (e.g. placements, volunteering, internships).	16 institutions who have implemented or will be implementing CR as part of a national consortium.

The project administrators, i.e. the career centers, typically look at the following:

- Typical progression patterns for various cohorts (discipline, WP, etc.);
- Predictive power for DLHE (Destinations of Leavers from HE) outcomes;
- Correlations to other employability measures;
- Relation to other metrics (NSS, retention, etc.);
- Implementation issues.

While best practices prove that learners' CR data (that is being generated and analyzed) provide a lot of value by offering insights on students' careers thinking and preparedness; identifying specific employability needs of groups, leading to targeted interventions; measuring the effectiveness of employability initiatives, etc., it fails to empower learners to benefit further from their own inputs beyond the limited timeframes of their higher education studies. Some universities, such as Ulster, offer access to personalized employability portals (McGivern; McCloy, 2018). Others offer tailored career center services for students to improve their progress throughout the course of their studies, but a review of the most recent use-cases nation-wide reveals that none of the piloting universities looks into the opportunity to hand over the ownership and "empower the learners" in line with JRC's report conclusions.

3. Blockchain as a Next Generation Distributed Database

According to the Knowledge Media Institute at the Open University "*the blockchain technologies may hold an answer to collating the outcomes of the new distributed learning reality*" and they intend to explore the possibilities that this infrastructure could provide. The new "distributed learning reality" can be perceived as both an opportunity and a risk to learns. As an example of the latter, 30+ million U.S. learners are now with some college education, but no degree or certificate, according to the National Students Clearinghouse (NSCH, 2016). In the spirit of the above statement, the authors extend the concept of a "*distributed learning reality*" and connect it to the concept of a "*distributed career reality*". As an example of the latter, a recent report by the U.S. Bureau of Labor Statistics, reveals that almost 25% of the workforce change jobs annually (2017).

This all leads to the assumption that for the new "*school-to-job-to-school-to-job....*" transition to happen in a frictionless manner, a distributed system is needed where data about individual learning and career aspirations and achievements can be recorded in an immutable manner and verified indisputable by multiple sources, being exchanged in a peer-to-peer way without the need for an intermediary and the associated costs around it. The multi-chain architecture of one such open blockchain platform, would allow for this transformation to occur without any changes in the internal systems and operations of the parties involved *(as seen on Figure 2)*.

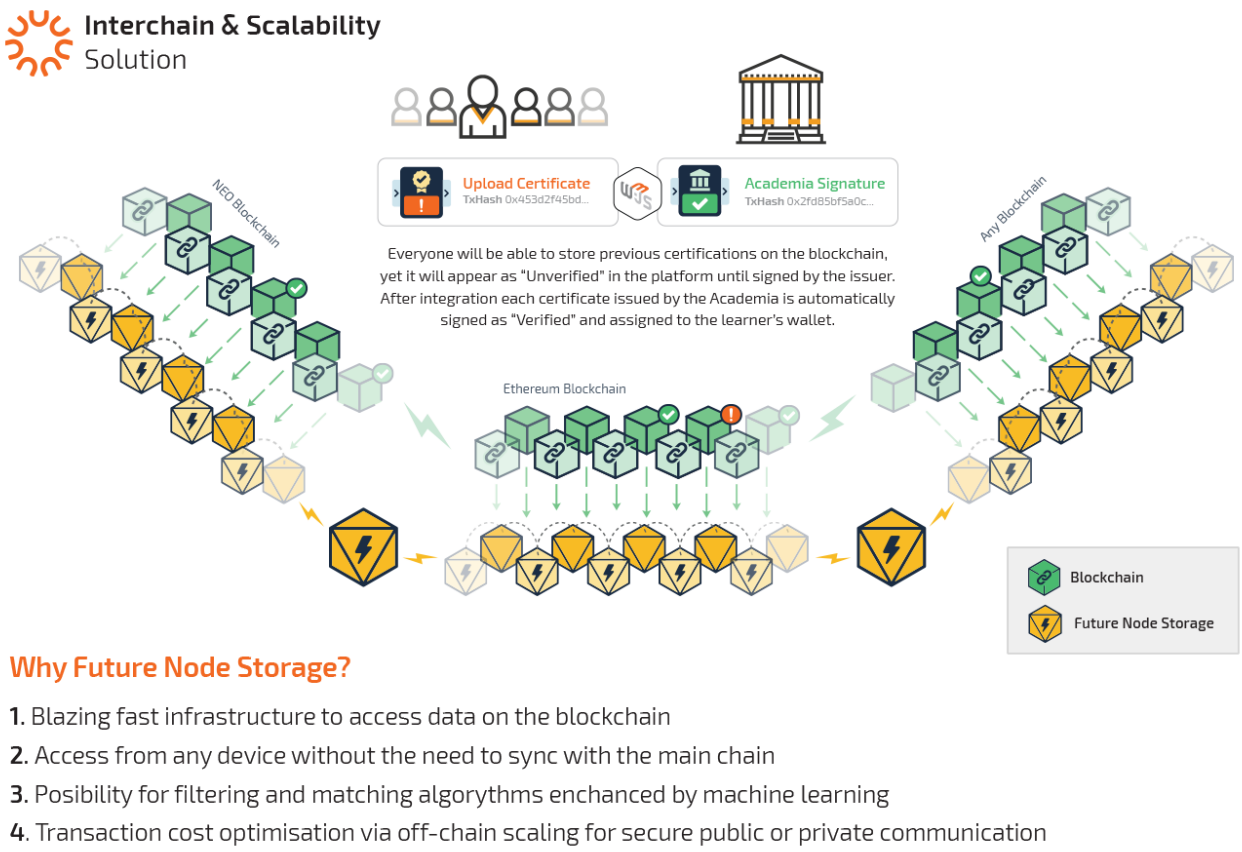


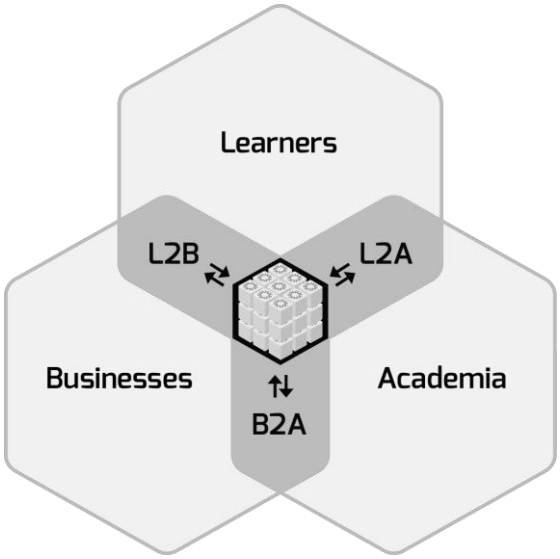
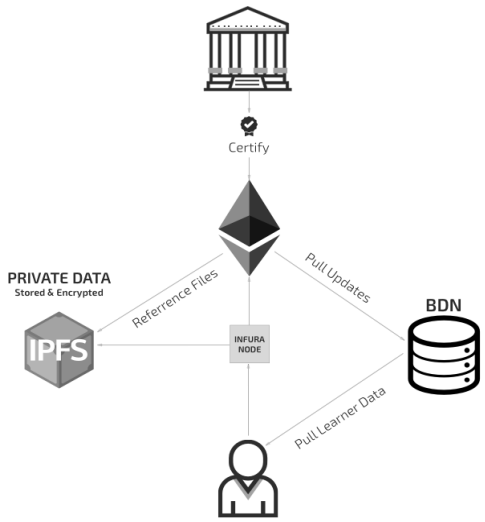
Figure 2. The multi-chain "Future Node Storage" architecture behind OS.UNIVERSITY

Securing the exchange of sensitive learners' information encrypted and transmitted over the blockchain network is of highest priority when it comes to turning a highly innovative project, such as OS.UNIVERSITY, into a success among universities that have a long-time record of difficulties exchanging data in a transparent, unified and cost-effective manner beyond their institutional borders. It is known that developers of smart contracts must be more security-focused than their traditional software counterparts as over the blockchain design and programming paradigms evolved exponentially and unlike traditional software where version upgrades is the norm, smart contracts are immutable once deployed. Therefore, the development team behind OS.UNIVERSITY is looking to implement a three-step security audit process, as outlined in its technical white paper (2017):

- First step would be for the testers to get fluent in the new paradigm of distributed trust computing (e.g. "Open Zeppelin"; "Oyente" certification);
- Second step would be to test every new version and upgrades of the smart contracts over a test network, while keeping learners' personal information off-chain, exchangeable on a peer-to-peer network, such as IPFS. The key rule for the information-coordination would be: "*you own the data, smart contracts help you exchange it, blockchain ensures the immutability of the exchanges*";
- Third step would be to implement a testing protocol for information security vulnerabilities (e.g. re-entrancy bugs, manipulation of contract outcomes, etc.).

Having taken the strategic, as well as the operational considerations in consideration, a framework to satisfy them all and to successfully enable the exchange of students' "Careers Registration" data through the blockchain from universities to learners to businesses (and back), would need to possess the following characteristics:

Table 1. Careers Registration in numbers

Strategic View of the Framework	**Operational View of the Framework**
	

4. Conclusion

Analyzing the opportunity for expansion of the benefits that CR promises (both qualitatively and quantitatively) and in line with the questions brought forward by the 3-year HEFCE funded pilot project to investigate the use of CR as a measure of learning gain in relation to work readiness (such as "*What is the best way to implement CR?"*), the authors of the current article conclude that there is a meaningful opportunity to enable students' data to yield long-term results by incorporating it into the so called "*individual learner wallet*", which the OS.UNIVERSITY project will offer to learners throughout U.K. as of June 2018 with the launch of its alpha-version on the open Ethereum blockchain.

Beyond the limited scope of the case-study that aims to analyze the relevance of the key value proposition behind OS.UNIVERSITY, as well as its practical implementation in regards to the "Careers Registration" project, there are additional arguments, coming from the current state of the global economy that support the premise for a self-sovereign educational and career identity beyond the borders of the academic institution and the time frames, associated with a 3-year undergraduate course:

- According to the World Economic Forum (2016), because of the "Industry 4.0", 35% of core employment skills will change between 2015-2020, thus the one-time measurement of "career readiness" upon graduation and entry in the workforce loses on its trait as an indicator of quality when it comes to the long-term employment and career prospects of the individual learner.
- According to latest data from OECD (2016), higher education penetration is as low as 15% in world's 2nd and 5th most populated nations - India and Brazil respectively. Even in developed economies, such as the U.K., only around 50% of population in engaged in higher education, which raises the question on how to bridge the gap with the other 50% when it comes to advancing "career readiness" among young people.

As a core value proposition, OS.UNIVERSITY's "*credentials wallet*", also referred to as a "*competence passport*", represents an immutable digital credentials portfolio to store and transfer throughout institutional and national borders credible information about personal accomplishments and achievements (originating from certifications, diplomas, etc., which are validated and verified though the blockchain). Thanks to a framework of L2A (learner-to-academia) and B2L (business-to-learner) smart contracts, deployed on the blockchain, the CR data, collected by the universities and fed into the learners' wallets, would achieve the following outcomes:

- ***L2A Smart Contracts*** – data about learners' accomplishments would enable smarter discovery of additional learning opportunities, which on its own will enrich the insights about learners' career aspirations, based on the autonomous choices of the learner in the online space beyond self-reporting.

- ***B2L Smart Contracts*** - the connection between (A) learners' data in regards to their career aspirations, enriched with information on the acquired (and relevant) knowledge and skills at any given point in time and (B) hiring businesses with matching requirements for these profiles, will happen automatically upon a "*handshake"*, enabled through a B2L smart contract.

By giving back the ownership over the CR data and its utilization into the hands of learners, thus enabling them to put it in motion on top of the open blockchain (providing trust and traceability of every event in the individual educational and professional development journey), learning gain has the perspectives to align with work readiness more effectively and efficiently.

Acknowledgments

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