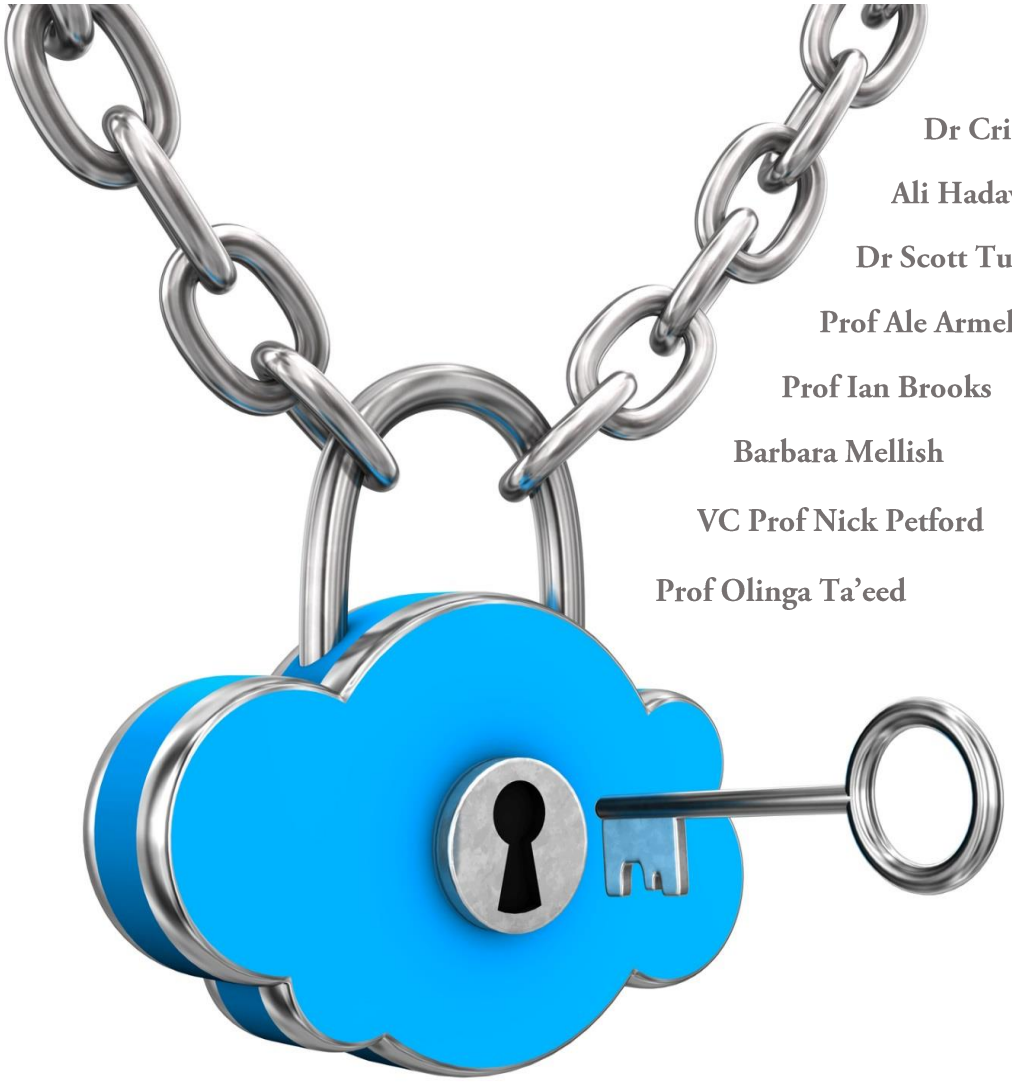

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Blockchain Educational Passport

Decentralised Learning Ledger (DLL)

Blockchain Educational Passport: Decentralised Learning Ledger (DLL)

Seratio Blockchain White Paper 5.03

30th April 2017

Preceding white papers[1]
Seratio Blockchain 1.0: Currency of Intangible Non-Financial Value
Seratio Blockchain 2.0: Values Based Impact Interventions
Seratio Blockchain 3.0: Proof-of-Impact Transaction Platform
Seratio Blockchain 4.0: Sandbox for Non-Financial Enterprise Solutions

Social Value & Intangibles Review: Blockchain Special (80 pages)[2]

Blog site: SocialTech–HumanitarianTech–FinTech[3]

Newsletters: February 2017[4], November 2016[5]

UN SDG Projects: Sustainability Development Goals[6]

Proof-of-Concept: blockchain.seratio.com[7]

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[1] https://github.com/seratio/whitepaper
[2] https://issuu.com/seratio/docs/social_value_and_intangibles_review_3109c1666e0df2
[3] http://mypad.northampton.ac.uk
[4] http://eepurl.com/cCQgJv
[5] http://eepurl.com/cnrY7L
[6] www.cceg.org.uk/lab
[7] http://blockchain.seratio.com

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Description*: The application of the blockchain technology to track, register, certify, and enhance the utilisation of acquired learning assets*

Abstract*: Following a series focused on measurement and transaction of intangible and non-financial value, Whitepaper 5.0 extends the use of the Ethereum based platform with integrated S/E Ratio SaaS to offer acknowledgement and utilisation of learning credits acquired by students and staff from pre-16, FE, HE, employment and CPD. Drawing from available examples of blockchain uses in education, the paper puts forward the concept of 'knowledge procurement' to develop a decentralised learning ledger (DLL) for the tracking, certifying and practical use of learning credits.*

Key words: *knowledge procurement, proof-of-learning, seratio blockchain, impact*

1. Introduction

1.1 The Building Blocks for a Decentralised Learning Ledger: Blockchain, Internet of Things and 'Knowledge Procurement'

Technological innovation is relentlessly changing the way we work and act and will do so faster in years to come. Progressive automation, the use and application of Artificial Intelligence, robotics, the Internet of Things (IoT), and much more are already impacting on our daily lives. Located within major economic and societal changes, such technologies demand new ways of relating to the reality we know, and to a virtual, augmented and progressively more global and relational hyper-reality we are constantly co-constructing and re-constructing through myriads of actions. We are experiencing the constant, challenging but also potentially fruitful shift towards a 4th industrial revolution fuelled by knowledge and resting on the capacity to learn and the ingenuity of applying learning in innovative, effective and just ways. It not surprising, therefore, to discover that one of the still unfilled needs of such transformation is that of keeping a record of human and machine activities.

Whitepaper 5.0 contributes to the above challenges by developing further the ideas and proposals of previous whitepapers in this series on the use of blockchain. Located within the need to find innovative, practical, and comprehensive ways to account for both the tangible and intangible value of

learning, this paper sets forth the argument that if knowledge is at the heart of current and future economic and social development, then we need to develop solutions able to capture, record, and improve the utilisation of knowledge resources. Central to the acquisition and utilisation of knowledge as a pivotal resource is how we afford, assess and make use of learning as a foundational block in the 'knowledge procurement' chain. The **Decentralised Learning Ledger** (DLL) is put forward as a proof-of-learning solution.

In developing the foundations for the DLL, the whitepaper will first introduce the three key concepts and ideas of Blockchain (B/C), Internet of Things (IoT), and 'Knowledge Procurement' (KP). It will then examine current innovative solutions in the field of blockchain for education.

1.2 Blockchain

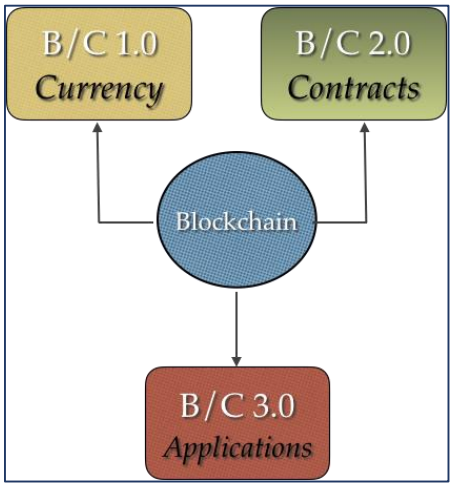
Blockchain is a potentially disruptive technology which was launched as a financial challenge in 2009 by Satoshi Nakamoto, although this is not his/her real identity. The Bitcoin cryptocurrency, which was its first manifestation, was a response to the financial and banking crisis and the loss of trust in the financial system. To start with, therefore, the purpose of Bitcoin was to create

> *'a digital currency and online payment system in which encryption techniques are used to regulate the generation of units of currency and verify the transfer of funds, operating independently of a central bank'* (Swan[8], 2015:ix)

The Blockchain provided the decentralised, distributed public and 'trustless' ledger onto which bitcoin transactions could be verified and recorded. Since then, the blockchain technology has evolved to include a series of other accountability purposes as shown in the figure below.

In more detail, Swan summarises the feature of each phase as such:

- **Blockchain 1.0** - *Currency*, or 'the deployment of cryptocurrencies in the application related to cash, such a currency transfer, remittance, and digital payment systems' [ix]
- **Blockchain 2.0** - *Contracts*, or, 'the entire slate to economic, market, and financial applications using the Blockchain that are more extensive than simple cash



[8] Swan, M. (2015) *Blockchain: Blueprint for a New Economy*. Sebastopol, CA: O'Reilly

transactions: stocks, bonds, future, loans, mortgages, titles, smart property, and smart contracts' [ix]

- **Blockchain 3.0** - *Applications*, or 'beyond currency, finance and markets, particularly in the area of government, health, science, literacy, culture and art' [ix]

The envisaged benefits of Blockchain, especially 1.0 and 2.0, are the efficiency and cost saving afforded by a decentralised and trustless system which removes the need for intermediaries.

The use of Blockchain for other purposes beyond the application to currency transactions have grown and so has the interest of governments and banking in developing further ways in which the blockchain technology can be used. A recent report by Walport, the Chief Scientific Adviser for the Government Office for Science (2016)[9] , describes the potential of blockchain as,

> '*Algorithms that enable the creation of distributed ledgers are powerful, disruptive innovations that could transform the delivery of public and private services and enhance productivity through a wide range of applications.*' (Government Office for Science, 2016: 5, emphasis in the original)

So why is blockchain so transformational? Because,

> 'We should think about blockchain as another class of things like the Internet - a comprehensive information technology with tiered technical levels and multiple classes of applications for any form of asset registry, inventory, and exchange, including every area of finance, economics, and money; hard assets (physical property, homes, cars); and intangible assets (votes, ideas, reputation, health, data, information, etc.). But the blockchain concept is even more; **it is a new organizing paradigm for the discovery, valuation and transfer of all quanta (discrete units) of anything, and potentially for the coordination of all human activity at a much larger scale that has been possible before'** [Swan, 2015, Preface, p. vii, emphasis added]

Such a vision, also called 'Internet-of-Value' or 'a Ledger of Everything', is no small statement. It takes accountability to a different level of play: a public, immutable, hyper-connected, and, possibly, more democratic and participatory way to account for human activities and interactions.

To help in visualising the possibilities of the technology, Blockchain 2.0 can be applied to the following examples of market transactions (Swan, 2015),

[9] Government Office for Science (2016) *Distributed Ledger Technology: beyond block chain*. London: Government Office for Science

Class	Examples of Blockchain 2.0 Applications
General	Escrow transactions, bonded contracts, thirty-party arbitration, multiparty signature transactions
Financial transactions	Stock, private equity, crowdfunding, bonds, mutual funds, derivatives, annuities and pensions
Public records	Land and property titles, vehicle registrations, business licenses, marriage certificates, death certificates
Identification	Driver's licenses, identity cards, passports, voter registration
Private records	IOUs, loans, contracts, bets, signatures, wills, trusts, escrows
Attestation	Proof of insurance, proof of ownership, notarised documents
Physical asset keys	Home, hotel rooms, rental cars, automobile access
Intangible assets	Patents, trademarks, copyrights, reservations, domain names

If Blockchain 2.0 can be thought of as an extended public accountability ledger, focusing mainly on the stipulation of 'smart contracts' (see Whitepaper 4.0), Blockchain 3.0 offers more innovative and more disruptive applications by making use of its potential as a 'higher-resolution activity tracking' (30) technology. Below are several examples and a brief explanation of how such tracking activity is envisaged to work (Swan, 2015).

Example	Description
Administration of all quanta	'a universal, seamless model for the coordinated activity of near-infinite numbers of transactions' (31) bringing human and machine closer together.
Facilitation of big data predictive task's automation	Closely related to the above, blockchain can 'help to turn prediction into action' (31).
Distributed censorships-resistant organisational model	The application of blockchain beyond financial efficiency and cost saving to the purpose of empowerment and freedom by making use of its immutable public record for enabling democratic checks and balances via transparency and access to information.
Namecoin: decentralised domain name system	The use of Namecoin, an altcoin, to verify Domain Name System (DNS) registrations which is transnational and not under the control of government or corporations. It can be used for registering domains in countries where there is no free speech (e.g., Alexandria and Ostel.
Digital Identity Verification	By using digital currency and personal wallets (see Whitepaper 4.0), for example OneName
Digital art: Blockchain attestation services (notary, intellectual property protection)	As the term *digital art* refers generically to all Intellectual Property (IP), blockchain technology can be used to verify and attest to the ownership of any form of IP. The process of attestation is done by the two key functions of 'hashing' and 'timestamping' and others such as Proof of Existence (http://proofofexistence.com/) and Notary (http://virtual-notary.org)
Blockchain government	There are a varieties of ways in which blockchain can be used for government purposes, such as, decentralised government services, dispute resolution, voting,
Science applications	Peer-to-peer distributed computing projects in which volunteers provide unused computing cycles (e.g., to reduce the wastefulness of the mining network)
Health	There are a number of possible and current applications, such as, the delivery of funds and supplies in response to a global crisis; donations to charities (currently using bitcoins); individual access to personalised health data (genomics), healthcoins, personal health record storage, etc.
Education	To be discussed further in this paper

1.3 The Internet of Things, platforms and the question of values

Although blockchain is envisaged by its proponents as a paradigmatic shift, it is one of the many major shifts presently occurring as part of the onset and development of a fully-fledged 'knowledge economy'. A brief introduction to IoT is needed to pave the way for the key drivers in users' participation and engagement with blockchain and with a DLL platform. Central to the discussion here is the changing notion of value and a redefinition of currency as not just a monetary exchange, but as a means for value generation.

The IoT is the age of platforms, or the evolution of the Internet to providing users not only with a service, but with an experience they co-create. Based on the emergent field of 'behaviour economics', the IoT is an 'ecosystem of everything being connected' (Manu[10], 2015: 4) and in which the traditional value chain of the industrial model of production is remodelled and transformed. In the behaviour economy the value added to the activity shifts from the satisfaction of having and using a product or service to the value of active experience and contribution to the experience through engaging in activities which fulfil one's personal sense of value.

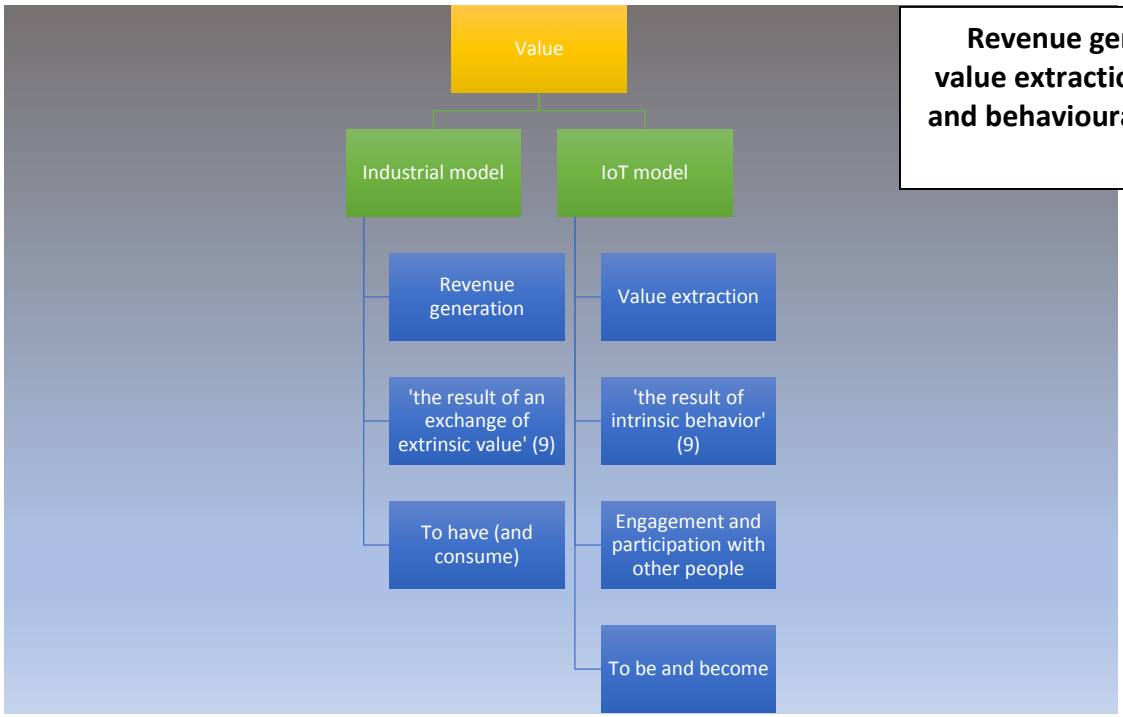
Value, in behavioural economics, can be defined as,

> 'the satisfaction of multiple dimensions of value, from physical to emotional, from social to intellectual, and from spiritual to occupational' (Manu, 2015: 9).

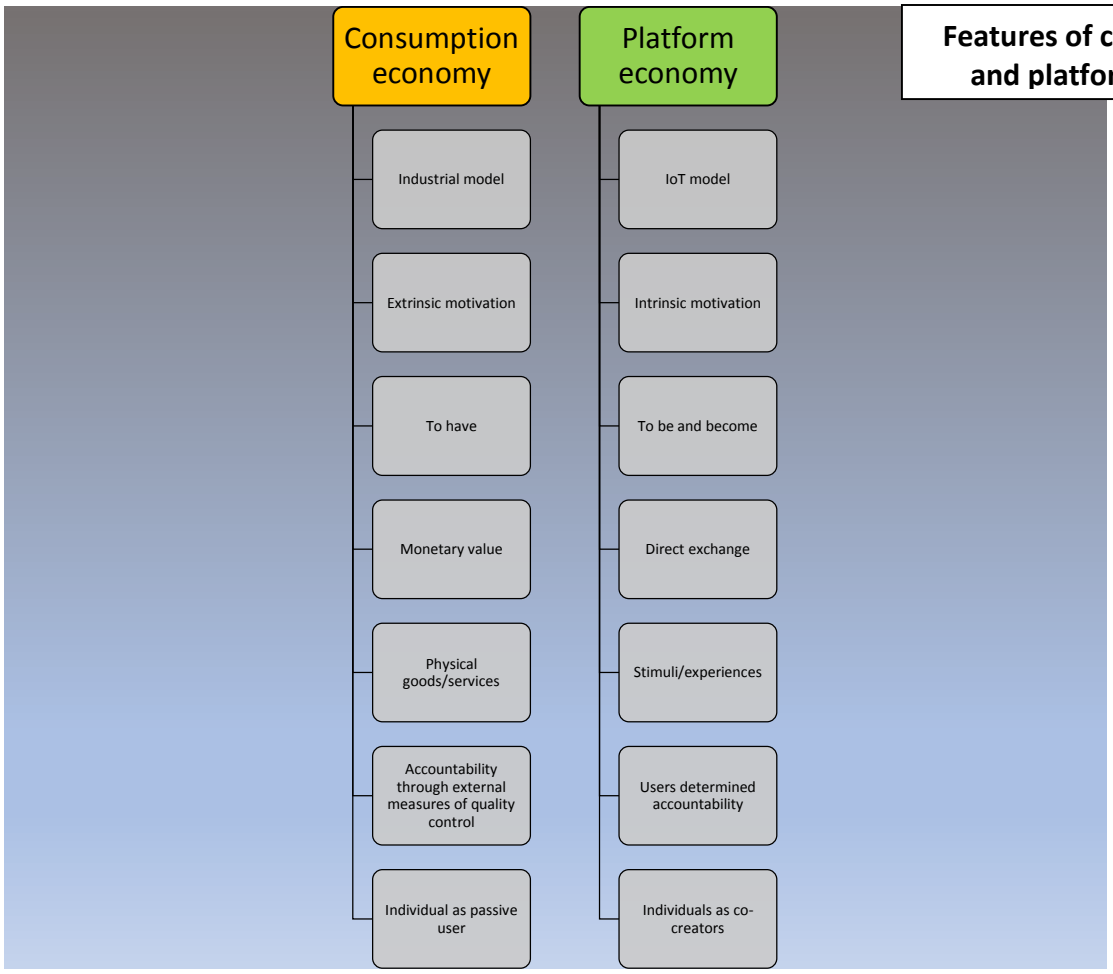
The implications for a DLL is that if the traditional model of industrial production can be conceived as revenue generation (profit), in the new economic context, the aim is 'value extraction', or creating value for each user in a personalised way (Fig. 2). From the perspective of individual learning, value extraction puts the learner at the centre as active doer and shapers of one's learning.

Of key importance for a learner-centred DLL is the way in which motivation for the desired behaviour changes from extrinsic to intrinsic. Such a change modifies the relationship between the user and the server (Fig. 3), or, in a more traditional sense between the consumer and the producer. While this change has wider economic ramifications, it is of importance for the adoption and exploitation of the blockchain technology, and for the way in which we can conceive the education service industry differently. One example, is how schools, colleges and universities can use blockchain's database of learning transactions to co-developed with students a more personalised response to learning needs and aspirations. The same can be said of the need to account for and support employability skills.

[10] Manu, A. (2015) *Value Creation and the Internet of Things: How the Behaviour Economy will shape the 4th Industrial Revolution*. Farnham, Surrey: Gower Publishing Ltd



Revenue generation and value extraction: industrial and behavioural economics compared



Features of consumption and platform economy

As explained earlier value in the new platform economy derives from how each 'user' or 'participant' extracts personal value from engaging with the platform's array of direct exchanges which should/could include the following types:

- *Spiritual* (beliefs, values)
- *Mental* (attention, inspiration)
- *Emotional* (love, hate, likes and dislikes)
- *Power* (teamwork, empowerment)
- *Passion* (desires, wants, goals, aspirations)
- *Safety* and *well-being*

The above 6 features can be understood as intrinsic motivational goals which sustain and enhance the value of the platform because, as Manu (2015: 18) states,

> 'The value of a product or service is proportional with its capability of becoming the perfect medium by which our motivating goals are satisfied'.

In this sense 'value' is personal and dependent on one's experiences and exposure to 'value moments' (18) which, in the context of the IoT, are intimately related to the extent to which the platform becomes a stage for individual performance of one's intrinsic motivations.

2.0 Knowledge Procurement

Artificial intelligence, automation, trustless and neutral accountability, are some of the key features of a new economic reality in which not only the means of production, but also the raw resources and the final products are reshaped. Consequently, such a shift in the economic fabric goes beyond considering knowledge as a *datum*, a given, acquired, transmitted, stored and applied in traditional ways. This new economic reality demands innovative ways to think about the implications for how knowledge, as a means and end of human activity, is envisaged, tracked, made visible and its impact measured and appreciated.

A discussion about knowledge procurement should start with the traditional understanding of procurement. The Chartered Institute of Procurement and Supply defines procurement as,

> '*buying the goods and services that enable an organisation to operate*'.

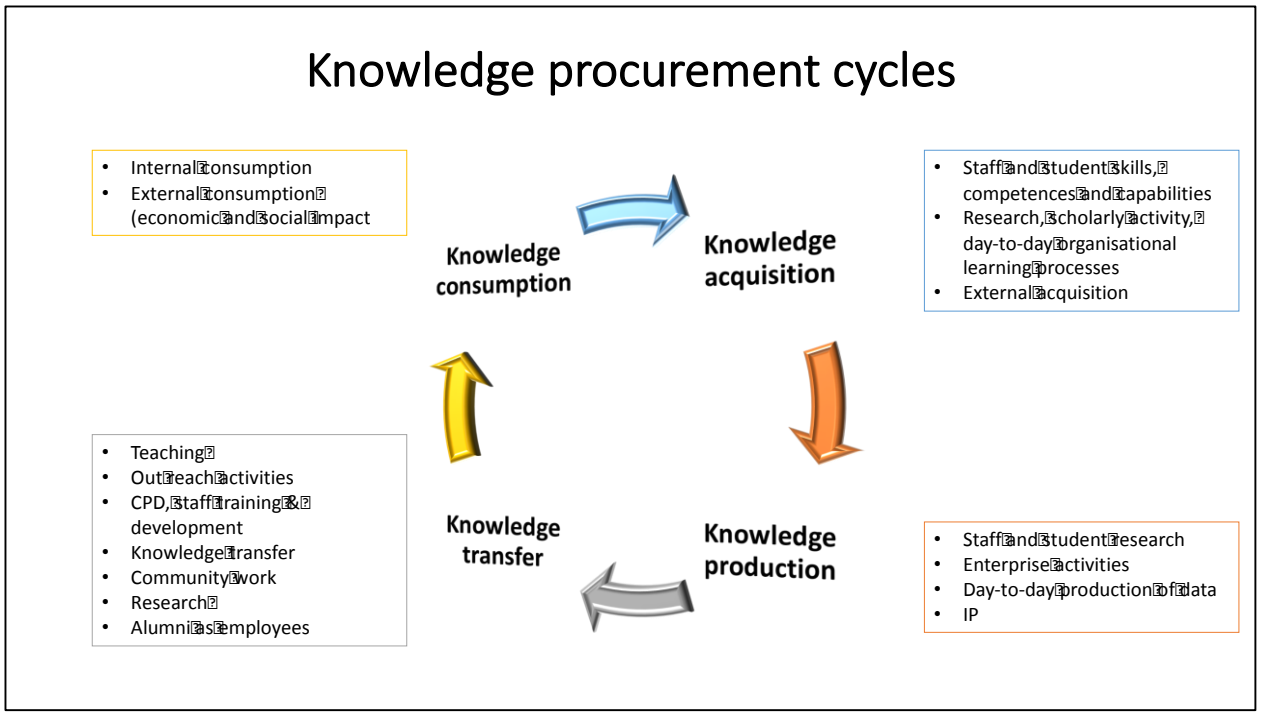
Firmly situated in the industrial model way of operating, the traditional definition of procurement views value as necessary to create competitive advantage while cutting costs through efficiencies. This adds value to the bottom-line by increasing profit and generating revenues. While this view of procurement is not necessarily inconsistent with changes in our perception of value, as shown in the preceding section, there are some key alterations which are pivotal in the appreciation of the knowledge procurement concept, and its relationship with the knowledge acquired through learning in its broadest sense.

First, is the question of how to conceive 'goods and services' about knowledge and therefore how to procure it in the first place; second, is how we can 'buy' such goods services, and how we can be assured of their costs and value; third, is the question of accountability across the whole procurement cycle and supply chain; and fourth, is a question of the impact of the procurement activity not only on efficiency, but also on fairness and social impact.

A first necessary mindset shift is on how we conceive the nature of the assets we intend to procure. An asset can be defined as what we own which can be used to produce value. Roughly speaking, assets can be categorised, amongst many ways, as tangible and intangible. Tangible assets are those which have a physical property and they can be fixed or current. Examples of tangible assets are buildings, equipment, machinery. Intangible assets, on the other hand, do not have a physical property and refer broadly to the 'know-how' within an organisation. This includes brand and intellectual property, and the generic balance sheet item of 'goodwill'.

Unfortunately, traditional financial accounting has only limited capacity to account for the value and nature of knowledge as an intangible asset. IP in know-how firms is only the tip of the iceberg and much of the knowledge asset within an organisation remains unseen and unaccounted for. Yet, knowledge is becoming a key asset and therefore its strategic acquisition, use and accountancy will be a primary consideration in future procurement activities. This will be particularly important for high-tech industries, but also for the education sector and particularly universities and further education colleges.

In such knowledge-intensive environments, knowledge is simultaneously the goods we need to provide the services which produce further knowledge and thus further goods and further services in a continuous set of cycles of knowledge production, consumption and innovation. However, universities and to some extent colleges are different from other know-how organisations in that their knowledge is transferred and does impact on the economy and society via their teaching, research and enterprise activities. In this sense, therefore, universities are also knowledge incubators, knowledge facilitators and a key lock in the knowledge procurement chain.



Knowledge procurement cycle – the case of universities and further education colleges

2.1 Blockchain for education: current initiatives

So far this whitepaper has highlighted the key features of blockchain and identified three key development: Blockchain 1.0, 2.0 and 3.0. It has also summarised some existing and potential uses for the blockchain technology especially regarding Blockchain 2.0 (smart contracts) and blockchain 3.0 (applications). As blockchain is a relatively new technology, much of current development is in its infancy. Yet, there is growing interest not only in the financial field where it started, but also in other important areas of human activity, such as government, health and education. Of these, education seems to be the least developed, although some emerging applications are developing fast. This section therefore summarises the key developments, initiatives and players in the field with the purpose to end with a proposal for how blockchain can be used for general educational purposes and how universities and colleges can capitalise and exploit the new technology.

An interesting place to start with is the recent **The blockchain for education** blog entry (http://hackeducation.com/2016/04/07/blockchain-education-guide) which states to be 'A guide to blockchain and education from someone who is skeptical about it.' This is not a bad start since many in the field of education would be skeptical if not outright critical and dismissive. A number of

businesses and ventures have invested in blockchain and education. To mention as few: Union Square Ventures, Khosla Ventures, Lightspeed Venture Partners, and Andreessen Horowitz.

Current uses of blockchain for education focus on 'identity' and 'smart contracts' by either using the Ethereum platform (of interest to Microsoft and IBM) and discussed in our Whitepaper 4.0; as a platform for assessment, as it is the case for Sony Global Education (https://www.sony.net/SonyInfo/News/Press/201602/16-0222E/index.html) which in 2016 'adapted blockchain* technology to the educational field and has developed technology that enables open and secure sharing of academic proficiency and progress records.' Described as the 'hassle-free certificates' (https://cointelegraph.com/news/sony-started-using-blockchain-for-hassle-free-education-certificates), Sony is not the only one to have developed ways to certify and attest learning credentials. Other examples are those of the Holberton School (https://blog.holbertonschool.com/using-the-blockchain-to-secure-and-authentify-holberton-school-certificates/) and the MIT Media Lab (https://medium.com/mit-media-lab/certificates-reputation-and-the-blockchain-aee03622426f) as two of the first example of using blockchain and bitcoins to certify and authenticate certificates.

Of more interest and a broader scope is the creation of the 'Learning is Earning' or 'the Ledger' platform (http://www.learningisearning2026.org). The Ledger is designed to be 'a complete record of everything you've ever learned, everyone you've learned from, and everyone who's learned from you. The Ledger not only tracks what you know - it also tracks all of the projects, jobs, gigs, and challenges you've used that knowledge to complete.' The above examples can be defined as the use of Blockchain 2.0 and 3.0 for notary purposes, as a portable and securely stored repository of individual achievements. Similarly, as Raths does in his blog **How Blockchain Will Disrupt the Higher Education Transcript** (https://campustechnology.com/articles/2016/05/16/how-blockchain-will-disrupt-the-higher-education-transcript.aspx), it can be seen as a 'more learner-centered alternative' to traditional university-based credentials.

Somehow more advanced in its development is the work done by John Domingue at the Open University (https://www.slideshare.net/johndomingue/the-potential-of-blockchain-in-higher-education). The framework suggested by Domingue incorporates both the ideas behind The Ledger and other certification initiatives, but goes further into making visible the connections between the learner and the learning in all its multiple possibilities. Not dissimilarly from 'Learning is Earning', the Open University's application also brings in the impact of learning on learner's employability. This is an understandable need since OU's students are part-time and mainly in employment.

To conclude and summarise, another blog, **10 ways Blockchain could be used in education** (https://oeb-insights.com/10-ways-blockchain-could-be-used-in-education/), provides a more comprehensive list of ways in which blockchain can be used for education. They are:

1. Single institution for authentication of certificates
2. Groups of institutions for shared repositories of certification and achievement, as in the example of some universities have grouped together in the US already
3. National blockchain database of all certificates
4. Global assessment (Sony Global Education)
5. Blockchain and badges – open badges to evidence credentials and safe storage
6. Blockchain and MOOCs – more reliable certification of MOOCs
7. Continuing Professional Development – currently CPD, and other forms of formal and informal work-based learning are diverse, and poorly tracked
8. Corporate learning
9. Apprenticeship
10. Bodies of knowledge

Specifically to the blockchain application to higher education, Don and Alex Tapscott in their **The Blockchain Revolution and Higher Education blog** (http://er.educause.edu/articles/2017/3/the-blockchain-revolution-and-higher-education) list four categories for innovators:

- *Identity and Student Records:* How we identify students; protect their privacy; measure, record, and credential their accomplishments; and keep these records secure
- *New Pedagogy:* How we customize teaching to each student and create new models of learning
- *Costs (Student Debt):* How we value and fund education and reward students for the quality of their work
- *The Meta-University:* How we design entirely new models of higher education in line with the former MIT President Chuck Vest's vision of a Meta-University (see Vest's publication here https://er.educause.edu/~/media/files/article-downloads/erm0630.pdf)

2.2 Blockchain for education: gaps, critical points, and technical challenges

Blockchain is a potentially disruptive technology, which is still untested in its application to a wider set of human activities. This last part of the whitepaper opens the discussion on three aspects of the application of blockchain to learning:

a. Current gaps and future opportunities;

b. Critical points of resistance to the adoption of blockchain;
c. Technical challenges for the application of blockchain.

2.2.1 Current gaps and future opportunities

The cursory summary of how blockchain has been applied to education has shown that the field is still underdeveloped. While this situation offers little in terms of comparison, it also provides ample opportunities for developing innovative ways in which blockchain can be used not only to attest transactions (Blockchain 2.0), but to develop into a fully-fledged decentralized learning ledger (DLL) with the capability to integrate traditional value chain's considerations about learning as a personal tangible asset with IoT's value as the intrinsic motivation to participate and co-create a lifelong learning experience.

Currently, the main innovations have been in the area of 'Identity and Student Records' (Tapscott and Tapscott) and within single institutions or groups of institutions. More can be done. The table below offers some insights into gaps and possible developments:

List of Blockchain's application and opportunities for innovation

Blockchain application	Gaps	Opportunity for innovation
Student identity/records	BC 2.0 – Certification, attestation; notary purposes; personal track record	Besides the obvious benefit of providing individuals with a track record of formal learning certificates, BC can also be used to certify the acquisition and application of learning in the workplace or in other contexts (e.g., volunteering)
Costs	No concrete example of this were found	As part of the DLL, blockchain can be used at the level of a single institution to bring together all transactions (learning of students and staff, research, enterprise, and admin running costs and investment) to show the added value of the single institution. The DLL will utilize both value for money cost effectiveness measures with added value considerations

		about a) student and staff experience and b) the economic and social impact of the institution.
Single/group of institutions	BC 2.0 – Certification, attestation; notary purposes. Some US universities	As above. Institutions can utilize existing collaborations (e.g., Ashoka U), or create further associations, for example, with businesses and other entities which benefit from the work of the single institution or group of institutions.
National database	Currently not found although Sony Global Education can be an example	The DLL and related measures (to be developed) would provide an alternative assessment to current evaluation criteria. They can be scaled up to become global databases and assessment measures (Alternative to/contributing to University league tables or PISA for schools). On a smaller and more practical scale, a national database will help schools to cater for transition (primary to secondary, secondary to FE; and FE to HE). In the same way, a EU database can provide the same support and be integrated into existing frameworks (e.g. the Bologna Agreement).
Global assessment	Sony Global Education – see Certification	See above.
Continuing professional learning, Corporate/Work-based learning, Apprenticeships	Examples not found – further research needed. All three items listed here belong to the category of work-based learning	Blockchain and the DLL can make tangible the learning which takes place, formally or informally, at work and therefore fill a gap in how individuals and businesses can make effective, efficient and fair decision on the employment

		and deployment of their workforce.
Bodies of knowledge: IP in its broadest sense; Pedagogical innovation, research innovation, informal learning, social impact of learning	BC 2.0 – smart contracts, IP, digital art	The DLL can enable individuals and institutions to record all knowledge contributions. In Higher Education these usually refer to research, but a variety of other knowledge contributions are not captured. These range from pedagogical contributions to enterprise work. Considerations should be given to existing IP legislation and institutional policy regarding the contractual nature of the IP.

2.2.2 Critical points

Specifically, to learning and education, a number of points can be raised ranging from the more pedagogical ones, to the financial and technical ones. The use of blockchain and the transformation of learning into another type of transaction also raises questions about the value of education, and the value of universities, further education and schools. Related to the issue of value, the transactional nature of the Ledger raises also questions about which party in the knowledge procurement chain has the authority to provide quality assurance and attest that the learning has a) taken place and b) has been applied.

- ***Blockchain reliance on Bitcoin or other digital currency*** – Besides the ideological resistance to linking education to a financial transaction, it is still not clear how blockchain will serve as a global ledger given that currently there are a variety of altcoin issued and used. If the use of digital currency is a pre-requisite, then should we consider creating a K-Coin, a knowledge coin digital currency? If this is a possibility, how can we ensure equity and a currency evaluation system of learning? What will each learning be valued at? EduCoin was an example of a global learning currency.

- ***Limits of a transactional view of learning -*** A more ideological criticism of using blockchain is that doing so will equate learning to a simple transaction, based on extrinsic motivation and the gaining of credential or badges as a proof of learning. Moreover, it will further stress the

financial, instrumental and extrinsic aspects of learning to the detriment of learning as an intrinsic, moral and democratic activity. The DLL in its more comprehensive aspects will account for transactions which have a social and economic impact and thus consider learning as a holistic activity.

- ***What would be considered a learning transaction?*** Traditionally learning is assessed through a variety of tests, exams and other activities which have measurable features and are mainly related to the acquisition of content or the application of knowledge, skills and competences. From a more technical perspective, and accepting that there are learning transactions already taking place, commentators query what, in learning terms, would be a transaction. The question becomes of even more practical importance regarding learning which takes place in informal and non-formal circumstances, and which is assesses soft skills, such as participation, engagement, support of others, and application of learning to work or society. (See Amy Collier on "Not-yetness and learnification.")

- **The place of trust in a trustless transactional ledger –** One of the key motivations for setting up cryptocurrency and blockchain was, paradoxically, the lack of trust in the banking system which acted as intermediaries for financial transactions. The decentralisation of trust would, therefore, be a challenge to the authority of educational institutions, such as universities and colleges, or other bodies which are currently benefiting from the need to train the workforce. It could be argued that blockchain and the DLL would enhance trust since they would require universities and other entities to redefine the criteria by which they trust each other. Of course, the redefinition of trust can have serious implications for institutions which have been used to depend on other, but externally imposed, quality assurance criteria. The issue of trust would deserve a far greater attention especially at the point of developing blockchain as a DLL. As useful question as a reminder, *quis custodes ipsos custodes* (who guards the guards)?

- **Institutional capability for the application of blockchain technology**: Like for every technological innovation, the questions of institutional readiness and workforce capability should not be overlooked. The adoption of blockchain and the running of fully-fledged DLL would require the upskilling, training and education of the workforce to start and thus changes in the way human resource department manage knowledge within their organisation, and a careful considerations of the costs involved. More broadly, it will also require raising awareness and persuading students and businesses of its usefulness and applicability to their needs.

- **Coping with inalterability of transactions and learning as change and development –** One of the ways in which blockchain technology creates trust within a 'trustless' decentralised ledger is to ensure that transactions are not alterable. Critics of the use of blockchain for education might be the inalterability of personal learning progression as undermining learning as inevitably alterable, developmental and progressive.

- **Data ownership and data protection –** related to the above point about the inalterability of transactions is the question of data ownership and data protection of personal learning achievements, and/or intellectual property derived from the application of learning, research or enterprise.

2.2.3 *Technical challenges*

- **Technological and human-related expertise –** although there is a current increase in courses focused on the use of blockchain, there is a lack of knowledge and expertise not only in the discipline of computing, but also in other disciplines across the natural and social sciences and humanities whose contribution would be needed to make blockchain and the DLL successful. While these can be no small challenges, they are also opportunities for course development and workforce training and professional development.

- **Mining costs –** Not to be dismissed is the current high costs and energy wastefulness of the process of mining. This challenge raises questions for the efficient procurement of energy requirements and the development of alternative and less costly mining protocols.

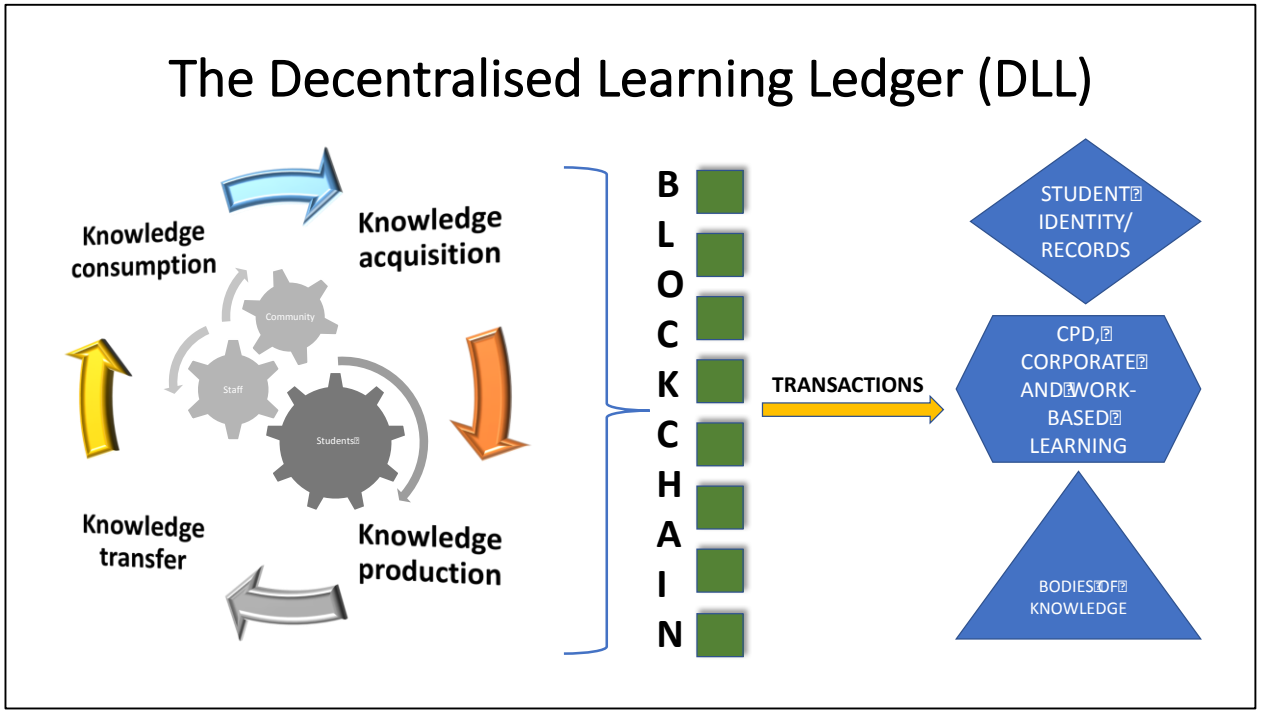
- **Hosting of DLL and related learning transactions** – Related to the challenge above is the problem of where to host the DLL and related learning transactions. Would a single institutional hosting be the solution? Or would a consortium of universities and colleges be a better way to cut costs and enhance efficiency? Or would the use of a third-party platform, like Ethereum, be a more feasible solution?

- **Data protection and data ownership** – Whether learning transactions and related smart contracts would be hosted within an institutional or third-party platform, the challenge of data protection and data ownership remain a technical and legal challenge.

3.0 The Decentralized Learning Ledger

Whitepaper 5.0 aimed to develop further the ideas put forward in previous whitepaper to explore the application of blockchain to intangible and non-financial assets such as education. It framed the task within current major economic changes such as the knowledge economy, and technological changes such as the Internet of Things. In doing so, the paper argues that blockchain can be the way in which the knowledge procurement cycle can be made visible and accountable.

Having reviewed some of the current applications of Blockchain 2.0 and 3.0 to education, it became clear that we are at the beginning of applying blockchain, but that, in theory, the modes of application and the opportunities for innovation are many, and at many levels – all compatible with the Blockchain Manifesto developed by Internet-of-Value Blockchain Alliance for Good.[11] This section puts forward the Decentralised Learning Ledger (DLL) as a framework for further discussion. The DLL incorporates many of the features of currently existing initiatives focused on the certification and attestation of formal learning (e.g., degree), but it also brings in some novel features in the form of learning transactions and regarding broadening the scope to the learning taking place within the entire organisation.



Decentralised Learning Ledger framework

[11] https://mypad.northampton.ac.uk/cceg/blockchain-manifesto/#.WQJat_krK01

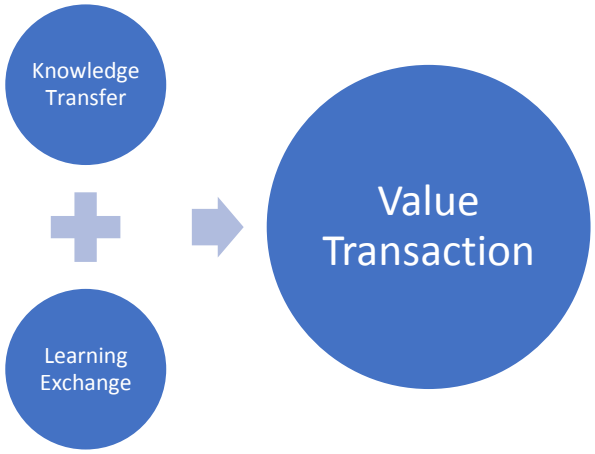
Regarding the learning transactions, the DLL will account for traditional certificates, but also for the acquisition of students and staff learning taking place in informal contexts, at the workplace and through outreach activities, such as volunteering. Each student and member of staff will have a personal L-wallet (Learning wallet) attesting contribution to learning set against the knowledge procurement framework.

In this way, the DLL will in time constitute a learning passport for individuals, but also an institutional database of accomplishments and impact showing through the chain of learning transactions the contribution to knowledge acquisition, production, transfer and consumption.

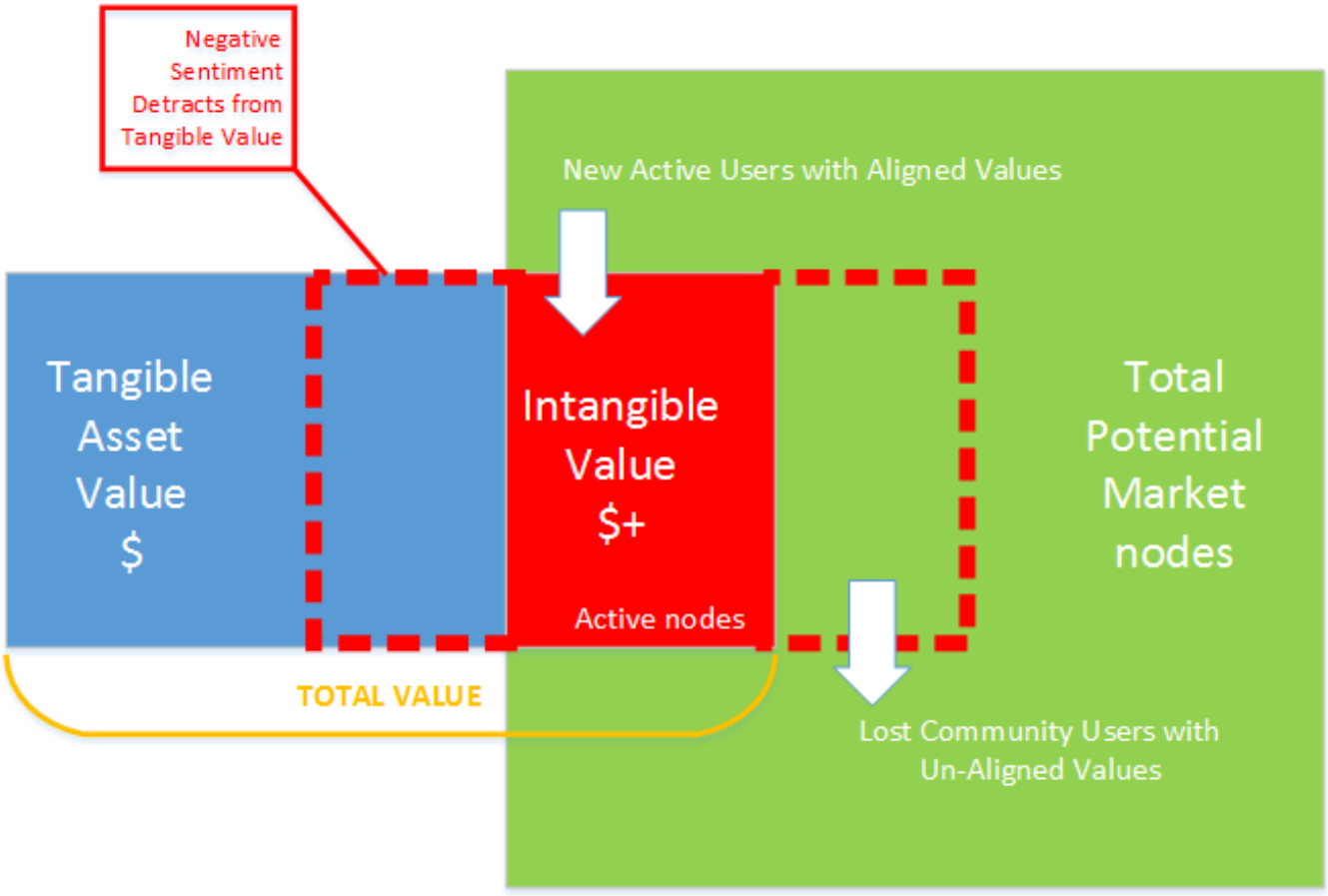
3.1 The Extrinsic/Intrinsic Integrated Blockchain

Like most learning paradigms, theoretical educational frameworks evolve the complexity of what appears to be simplistic into bewildering complexity. Activity Theory, for example, formulates the student environment, history, culture, and motivations as artefacts of influencing knowledge procurement. In addition, Blockchain needs this to be interpreted in terms of the transaction of value – an attribute it can work with.

	HARD	SOFT
Knowledge Transfer	Extrinsic	Intrinsic
Learning Exchange	Formal	Informal and Non-Formal
VALUE TRANSACTION	TANGIBLE	INTANGIBLE



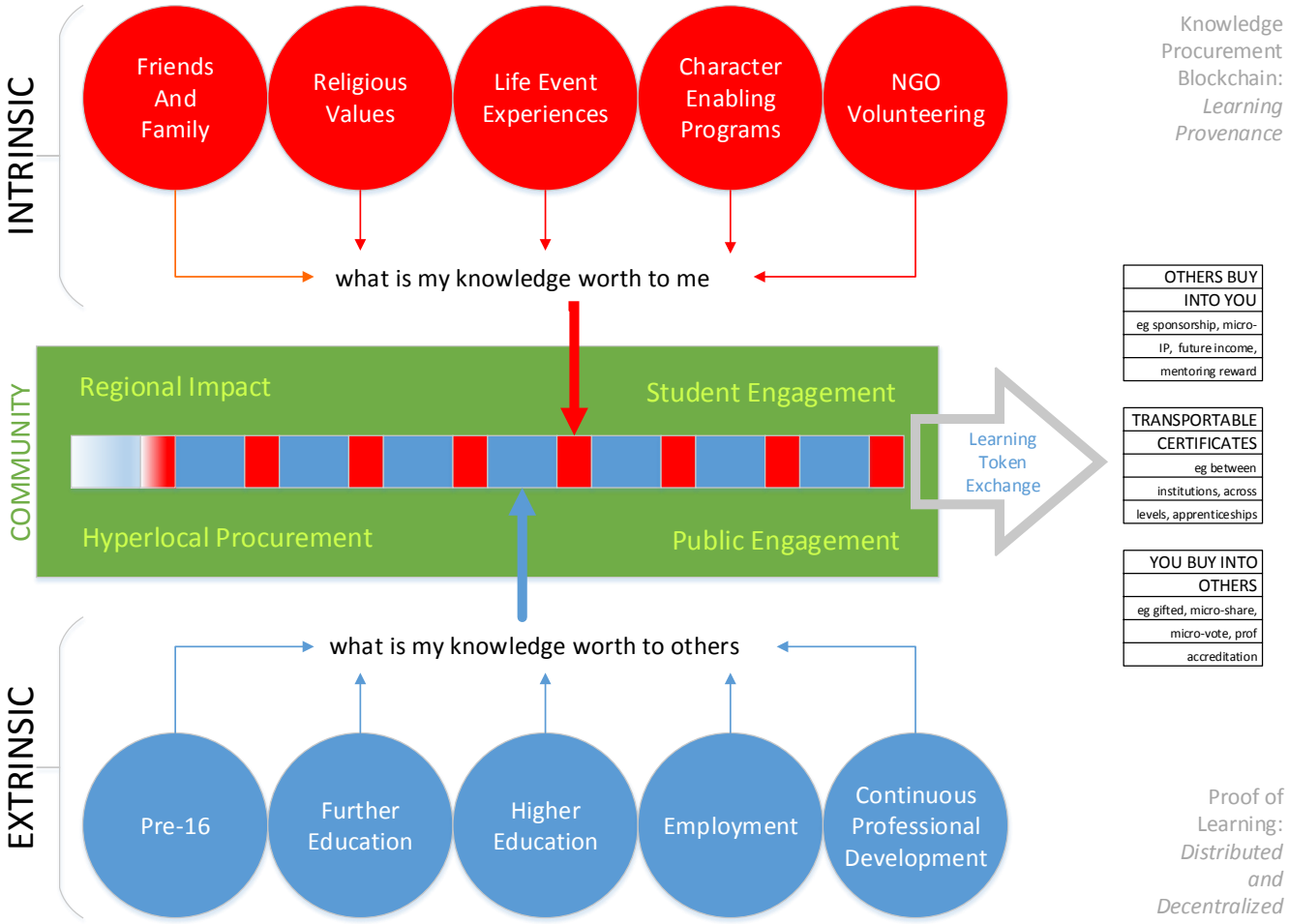
This implies that for the most efficient model of Total Value knowledge transaction to take place there has to be exchanges of both knowledge and learning conveying both tangible and intangible value to all parties; a combination of both IQ and EQ. Traditional blockchains are preoccupied with the movement of hard tangible (often financial) assets. The science behind capturing intangible and non-financial value, and transacting through blockchain has only developed over the last 12 months through the introduction of the Seratio Blockchain detailed in previous whitepapers in the series. In summary, the Seratio blockchain conveys both tangible and intangible value allowing the transaction of value through ones values. It digitally captures the intangible and non-financial value through the Social Earnings Ratio (S/E Ratio) which has the ability to digitize value, turns sentiment into tokens, and uses Fast Data (typically less than 10 seconds) – perfect for blockchain transactions to complete.



In essence, the greater the soft intangible value exchanged, and the greater alignment with the surrounding eco-system, the more effective the outcome and impact.

This has led to some very significant commissions based on the Seratio blockchain, including many non-financial and some quasi-financial systems:

- **Impact Investment**: SDG Coin supporting the United Nations 17 Sustainable Development Goals where funding is contingent on the impact (World Bank, International Development Bank)
- **Circular Economy**: City tokens for 360 interventions piloting in Bristol, Guangzou, Berlin, Mashad (youth) and Medellin
- **Belief Structures**: Religious tokens that allow transactions to occur contingent on adhering to specific religious values eg. Islam, Church.
- **Loyalty Discounts**: Rewarding 7 million MenCap carers in the UK with upto 50% discount at consumer EPOS dependent on the carer impact
- **Product Provenance**: The blockchain tracking of product traceability, part of transparency in supply chains, actively being pursued in the leather industry (farms-tannery-retail-landfill)
- **Women's Coin:** a financial token for women, by women, supporting female gender values.
- **Ethical Leadership**: Internal organisational token linking management behaviour to outcomes



The Seratio blockchain allows to us to devise the above Distributed Learning Ledger (DLL) framework.

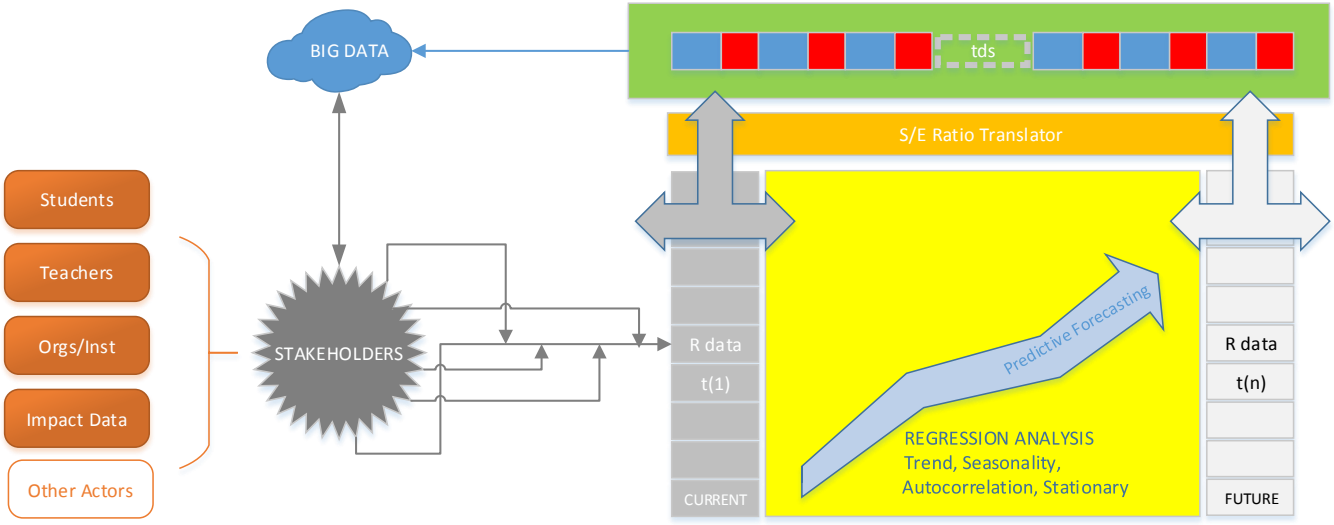
- A Learning Wallet, personally owned, that accesses a full history of both extrinsic and intrinsic learning of the individual held in a blockchain which can be private or public (or mixed?).
- The entire formal learning with 'badges', certificates, etc can be recorded from cradle to grave.
- The entire informal and non-formal learning can be captured and also recorded immutably.
- The ability to formally capture the knowledge and learning from non-formal environments like Ashoka universities and Changemaker attributes
- To measure and articulate the impact in the broader eco-system eg. regionally, public engagement, procurement, student engagement, etc
- To allow soft assets such as research IP to be recognized and traded through microshares.
- To tokenise the knowledge procurement to exchange, sell or buy with others eg. sponsorship of individuals, student coin recognizing learning with retail benefits, recognition of mentoring, etc.
- A multi-stakeholder, multi-level, multi-intervention framework of engagement through a single DLL framework and articulated through a single value metric
- To evolve a circular economy of exchange with modelling and forecasting capabilities

3.2 Big Data, Forecasting, and Linking Impact Outcomes

The proposed DLL answers many of the questions raised at 2.2.2 and 2.2.3 above bit it's only a first step in a journey. More importantly is how we transition from a Data intensive 'knowledge receptacle' paradigm of learning, to a Blockchain 'impact value' based world in education. Whilst the ultimate future suggests multi-nested blockchains of value exchange, this is very far from reality as there is not even an accepted unified blockchain protocol base such as Hyperledger. In this interim period, likely to last 5-10 years, we suggest a circular system that allows progressive adoption of legacy data into the DLL, ironically leading to the conversion of intangible data reintroduced into Big Data as tangible data. This gives us the best of both worlds.

BIG DATA	BLOCKCHAIN DATA
Captures indirect data before recognition of relevance	Verified, trusted public and private ledgers
Sophisticated, stable and tried/tested query tools	Decentralized, distributed and non-hierarchical
Well established and networked	Democratization: micro votes, micro shares, micro certificates

For DLL data entry we propose to borrow the structure from the Leather blockchain provenance project[12] which is currently underway with a 10-man development team. Essentially the big data attributes are manipulated through R programming and using an S/E Ratio algorithm turned into a Seratio blockchain compliant attribute that can be recorded on the blockchain.



[12] https://mypad.northampton.ac.uk/cceg/2017/03/23/supply-chain-provenance-from-cradle-to-grave-2/#.WQJ2C9y1u00

This means the DLL S/E Ratio will also be a single number metric representing learning, rather like NPS (Net Promoter Score) in retail customer loyalty – a litmus test that can easily be articulated to others. The other key advantage is the ability to forecast through predictive models by manipulation of the underlying big trend data. This is not to be confused with the complementary technique explained in Seratio Whitepaper 2.0 and 3.0 of using value as a finite element to forecast flow of value between people, organisations, products, etc. In particular, the latter technique models the flow of the value into the wider community and unrelated parties depending on the degree of alignment of their values to yours. This provides a direct correlation between those impacted and impacted within a multi-agency environment.

3.3 Engagement Impact

The question is can universities, research and educational institutes transparently and with verifiably data demonstrate this form of engagement? It is not that these institutions are not doing public engagement activities; but how to show it in a transparent manner. How to provide evidence to allow independent evaluation of the impact of this form of engagement? There are two issues here, in common with understanding the impact of any kind of intervention including CSR:

- Recording that the engagement actually happened
- Verifying that it had an positive impact

Blockchain as a decentralised ledger raises the opportunity of making the data on these activities more widely available, and protecting the sustainability of the data, the ‘chain’ would be distributed across the network, in effect backing it up. But, perhaps it goes further than this though - the blockchain is verifiable non-corruption of the data and unauthorised manipulation of it leads to the verification of the blockchain failing, giving further ‘integrity’ to the data.

As an example, outreach activities with schools and youth groups could be recorded. Each one event as a transaction in the chain. Within each transaction information such as - a unique code for school/youth groups; ratio of females to males; number of participants; date; unique code for each facilitator; length of the activity in minutes and may be satisfaction scores (sentiment analysis). Is this data recorded currently? Yes, many institutions will be recording some of this data, but this available only to the institution to process and analysed. What if some of this was anonymised and made available through a Blockchain approach? Then it could be relied on.

The personal details (including postcode, names, etc) would not be made publically available but may be coded, internal to the institution, to indicate which categories of the participants or facilitators belong to (e.g. primary, secondary, staff or student facilitators). Internally organisations would know which partners they have worked with and perhaps allocated resources accordingly. This

data would be made publicly available per institute. This can be mined to look at impact externally and if several institutions used the intervention, then impacting more widely. This would enable the use of tools from the growing area of network analysis to be applied to mine the data further.[13]

Whilst many impact measures, including S/E Ratio, have to measure if the intervention was welcomed and to what degree it was successful through a feedback loop, they often rely on data gathered by those claiming the intervention. Blockchain will provide the degree of transparency required to rely on impact data.

4. What Next: Paper to Pilot to Implementation

This whitepaper is being issued for discussion, amendment, improvement but mainly implementation. Whilst thought pieces are welcome, the reality is blockchain is full of noisy rhetoric with few proven working applications as yet. If indeed blockchain is the 3rd or 4th industrial revolution, then we are duty bound to ensure we prepare students for the challenges ahead in a blockchain world in terms of pedagogy, but also to ensure there is a glidepath for blockchain implementation within the field

4.1 Blockchain: Teaching and Learning Implications

The innovative nature and disruptive capability of blockchain technology, including the further creative development of the Internet of Things (IoT) and the power-potential of decentralised ledgers, present a leadership opportunity for world class universities in England, UK, and the world. More specifically, given the growth and productivity drag[14] posed by digital skills shortages[15] and the apparent lack of employability skills among computer scientist graduates, manifesting itself in relatively high graduate unemployment (HEFCE)[16], blockchain presents an opportunity for a game changing leap from skill shortage to new technology leadership. A move which can not only ensure that appropriately equipped graduates are highly employable and enjoy career success, but could also provide economy enhancing, productivity boosting credentials for the UK economy at a time when ensuring economic leadership faces particular challenges.

In short, as the UK led the global industrial revolution in the nineteenth century and the dissemination of its associated 'Anglo' economic culture, it could, with allies, lead this third generation 'industrial' revolution repeating the phenomenal benefits afforded by the first. Benefits only limited by the boundaries of our creative imaginations. As well as leading both 'research into' and 'use of' in higher education, universities should invest now in learning and teaching to ensure its current and future

[13] https://mypad.northampton.ac.uk/cceg/2017/04/21/transparent-public-engagement-could-blockchain-help/#.WQYvsNy1u00

[14] http://www.hefce.ac.uk/pubs/Year/2017/CL,082017/

[15] Tech City Report 2016, "Digital skills for the UK Economy" January 2016

[16] http://blog.hefce.ac.uk/author/professor-sir-nigel-shadbolt/

graduates, notably in digital technology/computing science/ICT and related disciplines, together with those in business schools, technology, innovation and creative disciplines, are afforded the opportunity to enhance their digital capabilities and, specifically, the myriad of knowledge, understandings and skills embraced by blockchain technologies and their creative usage.

A carefully constructed, highly flexible, yet accessible, series of interrelated Level 6 (final year undergraduate) and Level 7 (postgraduate) on-line modules could be developed. These would be initially accredited by a small pilot university set (and their dissemination nationally encouraged) as both stand alone, enhancement, activities and, better still, integrated within degree programmes. These credit bearing, state-of-the-art learning experiences will embrace both blockchain technology and their creative usage and multiple applications. These can contribute to the learning outcomes of and, hence, graduate capability, of a wide range of degree programmes creating an on-going cadre of capability, a source of national economic distinction to lead and attractive the world's finest wealth creators taking the knowledge economy to its next generation of capability and impact.

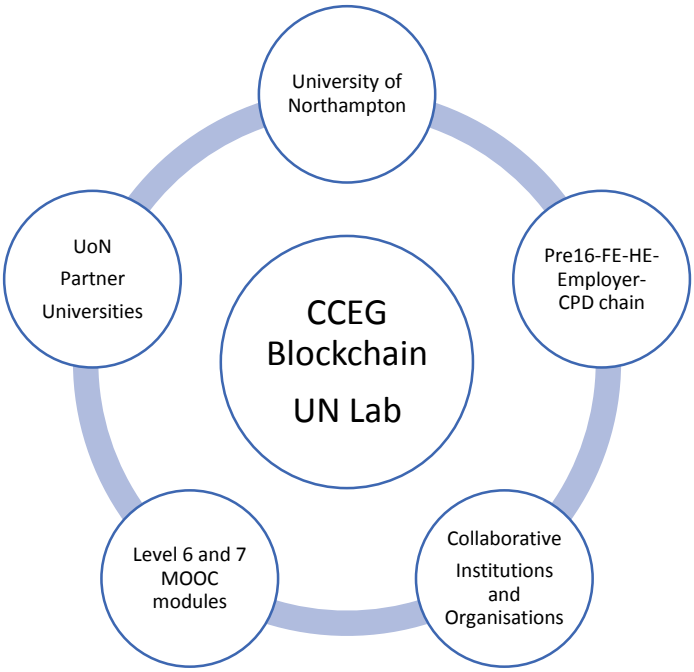
Furthermore, universities could not only embed these 3rd industrial revolution learning outcomes in their programme, they can ensure wider access to such learning by both creating on-line learning packages at Level's 6 and 7 but also whole-degree offerings aimed at both the committed innovative technologist and the creative personality able to take real-world blockchain application practice further. This development can embrace campus based provision, on-line distance learning and provide non-traditional degree level access, such as Graduation Apprenticeships for in-work learners, ensuring potentially rapid learning-to-application.

Given the global reach of UK universities, University of Northampton is certainly no exception, this learning can be shared among its extensive English, private and FE providers, and overseas learning/teaching partnership network via embedded learning outcomes and on-line learning modules on awards of the University. This development in learning and teaching will not only address the reported skills shortages in digital technologies among English graduates, it will also provide global leadership of a disruptive technology placing English universities at the international forefront of this approaching economic revolution. We'll only be given one chance; innovation will not wait.

4.2 Sandbox Pilot

A proposed pilot would require to test the broad components proposed in this paper.

- Level 6 and 7 Blockchain learning via MOOC's
- DLL across vertical partners in one region (pre-16, FE, HE, Employers, CPD) testing passport input challenges
- DLL across horizontal peer partners testing passport portability
- Other institutional and organisational collaborators across public, private and civil society



We envisage this to be a 2 year pilot with enterprise level implementation taking a further 12 months in year 3. The initial DLL sandbox platform is currently in development (Whitepaper 4.0) and scheduled for release in Q4 2017.

5.0 Future: What Problems Does this Resolve?

It's evident that this approach will lead to many new avenues hitherto unavailable to educational frameworks and only briefly touched upon here. Of course it's not a trivial exercise and difficulties ahead. Disruptive and radical departures rarely are, but potentially very rewarding for a sector that has for too long been preoccupied with formal extrinsic learning and ignored the intrinsic transformation of students which goes largely unrecognised and unrewarded. This may be because previously it was thought too difficult to measure but even then, what's the point of capturing knowledge if you can't transact it? Blockchain allows us to do that.

Critiques would say that mankind has done very well without such a revolution in education. It is true that education has served us well but it is now hierarchical, centralized, and controlled by 'the man'. Blockchain is anti-authority, decentralized and distributed with no single power held by anyone, except the individual.

5.1 Potential in Further Education

Further Education professionals always defend the mission of their sector as much more than qualifications gained by their graduates. If that is true for Higher Education, then it's certainly equally true for HEIs (Higher Education Institutions). FE professionals invariably ascertain that the impact of their work on community cohesion, wealth creation, economic growth, aspirations for success and prosperity are never quantified and are rarely acknowledged beyond sentimental acknowledgments.[17] [18]

Policy makers and funders are equally challenged as they have no way of associating impact with policy and funding. It has been accepted for sometime that proxies are the only way to measure impact. That is to say, the number of people qualify at a certain level in a certain discipline is associated with closing that skills gap in the economy. For example, the number of people qualified at level 3 in plumbing is proxied to the plumbing skills in faced by the construction industry. In other words, these proxies are the only way for policy makers and funders, who are concerned, amongst other things, with closing skills gaps in the economy to use for the supply of skills.

DLL offers a much more effective linkage between the skills gained by individuals, the impact on the local economy, on community cohesion and such mission critical measures to the work of FE.

5.2 Potential in Higher Education

Blockchain, blockchain, everywhere. Just google blockchain and add any subject you desire, and you'll find a raft of acclaimed solutions which are often highly technical, sometimes philosophical, and often delivered with religious fervour. As either the 3rd or 4th industrial revolution, blockchain is hailed as the panacea to all ailments of society.

And yet, we're in agreement with Prof Marnie Hughes-Warrington (Deputy VC, Australian National University), that it's surprising how HE remains behind the curve. We started tracking blockchain in May 2016 and by September we had identified 37 foundations examining the technology, but by November 42 blockchain labs had already formed.[19] But even in the relatively pedestrian academic world, things are starting to move rapidly. In the last 7 days UCL have launched their website claiming 75 researchers[20], and Melbourne University launched their micro-credit Distributed Ledger

[17] Hadawi & Crabbe 2017, Developing a Mission for Further Education: Changing Culture using non-financial and intangible value, Association for Research in Post-Compulsory Education: ARPCE, June 2017

[18] Sir Andrew Foster, A review of the future role of further education colleges, 2005 www.dera.ioe.ac.uk/5535/1/realising06.pdf

[19] http://www.afr.com/leadership/university-of-melbourne-first-in-australia-to-use-blockchain-for-student-records-20170427-gvubid

[20] http://blockchain.cs.ucl.ac.uk/

Technology[21] with several Australian universities like Deakin already in trials. MIT's Media Labs are now serving around 10 global universities with their Blockcerts[22] licenses, and in the UK the Open University's Prof John Domingue is working on their variant for their 150,000 students. Also recently, EPSRC have awarded UK£ 3.6m in blockchain grants across 7 projects[23], the EU put aside a budget of €500,000 for an observatory[24], and NESTA received EU money for their Blockchain Lab.

It is not surprising, of course, that the early adopters are those university institutions which are both large and with a broad democratization of knowledge agenda eg. MOOCs or education available to the masses. Understandably, the concept of decentralization of learning across distributed networks sits less well with institutions who trade on their hierarchical reputations. But we have to face it, blockchain is not a passing fad, it is a revolution that has arrived, so the only remaining question is how do we embrace it?

In some respects we were fortunate to identify the technology early on. The University of Northampton's spin out Think Tank, the Centre for Citizenship, Enterprise and Governance (CCEG)[25], works at the forefront of the movement of value. With its 60,000 members CCEG developed metrics for capturing and measuring intangible and non-financial value for legislative frameworks like the Social Value Act 2012 and Modern Slavery Act 2015, but last year decided to move into the transaction of those 'soft' assets through blockchain. The concept of transacting value through your values is very germane to most university's impact agenda on student and local engagement. This has been further amplified by our own demographic which attracts students from more challenging backgrounds. Indeed our Ashoka Campus status has directed our focus on equipping our students with 'Changemaker' attributes as one of the leaders in social innovation. To do this, however, needs us to recognise the intrinsic and extrinsic value we bring to our students and the region, beyond the formal certificated learning which we have in common with others.

We have turned to a joint venture with the CCEG Blockchain UN Lab[26] (who focus on United Nations Sustainable Development Goals[27]) to capture, articulate and transact that value. We are developing a Blockchain Educational Passport based on a Decentralised Learning Ledger (DLL) capturing, uniquely, not only formal but also informal and non-formal learning. Our goal is to track knowledge procurement from pre-16, Further Education, Higher Education, Employer, CPD and also digitise the impact value to the student, staff and the region. We have started with this Whitepaper 5.0 which we invite you to read, comment, and perhaps work with us in the collaborative spirit that the Open Source movement has so long promised, and is now finally delivering to transform our society.

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[21] http://newsroom.melbourne.edu/news/melbourne-university-pilot-distributed-database-micro-credentials-0

[22] https://www.blockcerts.org/

[23] https://www.epsrc.ac.uk/newsevents/news/distributedledgertechnologytransformenergybankinghealthcare/

[24] https://www.theregister.co.uk/2017/04/20/eu_plans_for_blockchain_observatory_raise_concerns_says_expert/?mt=1492769268071

[25] http://www.cceg.org.uk

[26] http://mypad.northampton.ac.uk/cceg

[27] http://www.bisgit.org/lab

6. Background Note

Information on the open source Social Earnings Ratio® (Creative Commons, 2011) may be found at the Open Source not-for-profit Think Tank, Centre for Citizenship, Enterprise and Governance (www.cceg.org.uk) which focuses on Movement of Value. CCEG has received over 100 commissions, shown at www.socialearningsratio.com and operates 10+ SaaS platforms through the trading arm Seratio Limited (www.seratio.com). CCEG has over 60,000 members including 7,000 heads of CSR of the world's largest companies and 2000 politicians. Members receive the journal Social Value & Intangibles Review https://issuu.com/seratio. CCEG has founded the IoV Blockchain Alliance for Good (Bisgit.IoV) at www.bisgit.org, as well as the CCEG Blockchain UN Lab. CCEG and Seratio are spin-outs from the University of Northampton both adhering to the Blockchain Manifesto.

6.1 Whitepaper Schedule

Updates are available at: https://github.com/seratio/whitepaper

1.0 Currency of Intangible Non-Financial Value (October 2016)
2.0 Values Based Impact Interventions (December 2016)
3.0 Impacting With Value: Capture-Translate-Transact-Report (February 2017)
4.0 Seratio Platform Architecture (March 2017)
5.0 The Blockchain Educational Passport (April 2017)
6.0 Transference of Value across Scale
7.0 Zero Sum Gain Acknowledgement of Value – where value is not transacted, lost or gained
8.0 Niche Applications (Ethical Leadership, Mental Health, Health & Wellbeing, Eternal Value, Brand Value, Provenance, Capacity Development, etc)

6.2 Contact

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