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### How to cite:

Mikroyannidis, Alexander; Domingue, John; Bachler, Michelle and Quick, Kevin (2018). A Learner-Centred Approach for Lifelong Learning Powered by the Blockchain. In: EdMedia: World Conference on Educational Media and Technology, 25-29 Jun 2018, Amsterdam, Netherlands.

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Version: Not Set

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# A Learner-Centred Approach for Lifelong Learning Powered by the Blockchain

Alexander Mikroyannidis, John Domingue, Michelle Bachler, Kevin Quick  
Knowledge Media Institute, The Open University  
United Kingdom

{Alexander.Mikroyannidis, John.Domingue, Michelle.Bachler, Kevin.Quick}@open.ac.uk

**Abstract:** The emergence of Blockchain technology promises to revolutionise not only the financial world, but also lifelong learning in many different ways. Blockchain technology offers opportunities to thoroughly rethink how we find educational content and training services online, how we register and pay for them, as well as how we get accredited for what we have learned and how this accreditation affects our career trajectory. This paper explores the different aspects of lifelong learning that are affected by this new paradigm and describes an ecosystem that places the learner at the centre of the learning process and its associated data. More specifically, we outline the ways that ePortfolios, accreditation and tutoring can evolve within this learner-centred ecosystem and we discuss the various benefits that this evolution bears for lifelong learners.

## Introduction

Education today is still controlled mostly by educational institutions, which offer quality, credibility, governance, and administrative functions. This model is not flexible enough and poses difficulties in recognising the achievements of a lifelong learner in informal and non-formal types of education. As a result, a lifelong learner's transition from formal to informal education and vice versa can be hindered, as the achievements acquired in one type of education are not easily transferable to another (Harris and Wihak, 2017, Lundvall and Rasmussen, 2016, Mayombe, 2017, Müller *et al.*, 2015). Generally, lifelong learners have limited control and ownership over their learning process and the data associated with their learning. This indicates the need for a learner-centred model across all types of education, offering learners with a framework for fully controlling how they are learning, how they acquire qualifications and how they share their qualifications and other learning data with third parties, such as educational institutions or employers.

The Blockchain is best known as the technological underpinning for the Bitcoin cryptocurrency. Blockchain technology, which can be thought of as a public distributed ledger, promises to revolutionise the financial world. A World Economic Forum survey in 2015 found that those polled believe that there will be a tipping point for the government use of Blockchain by 2023.<sup>1</sup> Governments, large banks, software vendors and companies involved in stock exchanges, especially the Nasdaq stock exchange, are investing heavily in the area. For example, the UK Government recently announced that it is investing £10 million into Blockchain research<sup>2</sup> and Santander have identified 20-25 internal use cases for the technology and predict a reduction of banks' infrastructure costs by up to £12.8 billion a year.<sup>3</sup>

Blockchain technology offers a decentralised peer-to-peer infrastructure where privacy, secure archiving, consensual ownership, transparency, accountability, identity management, and trust are built in at the software and infrastructure levels. As such, the Blockchain has the potential to revolutionise education in a number of ways. In this paper, we explore some of the applications that the Blockchain can have on certain aspects of lifelong learning, including ePortfolios, accreditation and tutoring. We discuss the innovative paradigms introduced by each of these applications, with the goal of building a learner-centred ecosystem for lifelong learning.

The remainder of this paper is organised as follows. First, we present the overall scenario that is driving our learner-centred approach for lifelong learning. Subsequently, we describe our approach, focusing on the core elements of ePortfolios, accreditation and tutoring, and discussing how these elements are enhanced by Blockchain technology. Finally, we conclude the paper and outline the next steps of this work.

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<sup>1</sup> <http://www.coindesk.com/world-economic-forum-governments-blockchain/>

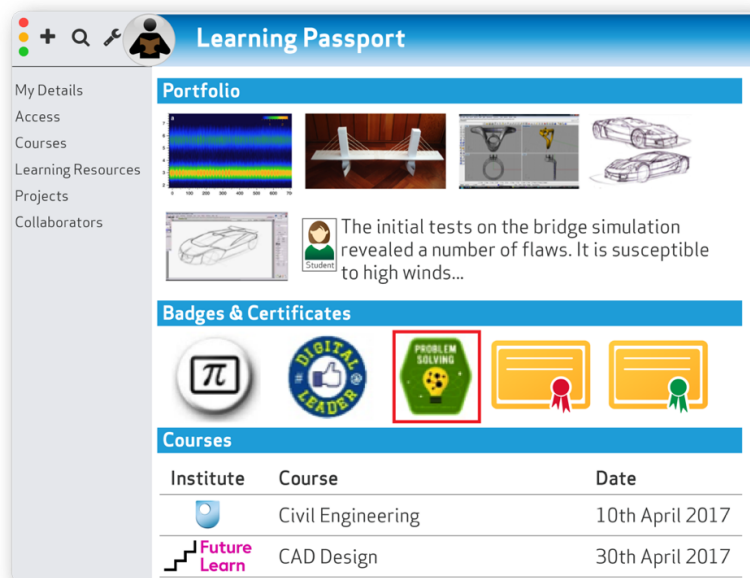
<sup>2</sup> <https://www.cryptocoinsnews.com/the-uk-treasury-is-embracing-block-chain-digital-currencies-and-big-data-research/>

<sup>3</sup> <http://uk.businessinsider.com/santander-has-20-25-use-cases-for-bitcoins-blockchain-technology-everyday-banking-2015-6>

## A lifelong learning scenario

The following scenario demonstrates the potential impact of Blockchain technology on lifelong learning. Let us consider Jane, who works as a Junior Data Analyst in a London-based company. She is 30 years old and holds a B.Sc. in Computer Science. She is keen to advance her career in the field of Data Science; however, her demanding work schedule and daily commute do not allow her to return to full-time education for acquiring further qualifications. She is interested in informal and non-formal methods of learning, but she also seeks to acquire some type of accreditation for her learning.

Jane creates her personal Learning Passport (shown in Figure 1), which is powered by Blockchain technologies and offers, among other things, a learning portfolio, smart badges, as well as opportunities for social learning and peer mentoring. We can see in Figure 1 that the top main panel (labelled 'Portfolio') contains artefacts that Jane has created with her peers during her courses. Selecting the top left item – the output of a simulation program – causes related feedback received ("The initial tests..."), associated badges or certificates, and relevant courses (the CAD Design course), within the list of current and completed courses in the bottom panel (labelled 'Courses') all to be highlighted.



**Figure 1: Example of a Learning Passport.**

Jane enrolls to relevant open online courses offered by Higher Education Institutions (HEIs) in the UK and abroad, as well as relevant Massive Open Online Courses (MOOCs). Upon completion of these courses, she acquires certifications in the form of smart badges, which are added to her Learning Passport. Apart from just evidence of learning, the smart badges that Jane has earned can be used as dynamic accreditations in a number of ways, thus helping Jane in achieving the following goals:

- Finding new courses based on the gap between Jane's current skills and her desired jobs
- Finding new job opportunities that match Jane's qualifications
- Acquiring job promotions based on the new skills that Jane has mastered
- Networking with other professionals and learners with similar backgrounds and learning goals as Jane
- Identifying other learners that Jane can mentor and tutor in exchange for money or reputation points

Jane is building her learning portfolio, which consists of the courses she has enrolled to, her assignments and the results of other exercises she has completed such as quizzes, as well as the smart badges she has earned. All data in this portfolio is owned by Jane, who can also encrypt it or select subsets of it for release to others for a fixed

duration. For example, Jane can release parts of her portfolio to potential employers two weeks before an interview. She may also offer access to HEIs, educators / trainers and other learners that follow a similar learning journey.

All transactions associated with Jane's Learning Passport are signed and time-stamped. The fact that the transactional record is visible to all and immutable resolves many of the problems associated with identity and fraud. As all data is permanently accessible, different consensual mechanisms can be put in place to link learner work to formal feedback and assessment. If desired, any principles underlying formal statements can be encoded in Smart Contracts, which allow the encoding of organisational rules, so as to be explicit for any interested party.

Jane finds micro-courses that have been produced by independent tutors and gains access to them via micro-payments, similar to purchasing an app on her smartphone. She studies these micro-courses and offers her feedback via ratings that count as reputation points for the authors of these learning materials. Other tutors can also reuse and repurpose these learning materials, upon agreement with the original authors. Jane decides to produce a free micro-course on the R programming language, based on what she has learned, in order to earn reputation points and enrich her portfolio.

Additionally, Jane has access to a network of learners that study together online and mentor each other. She chooses to mentor an early career data scientist in basic data analytics methodologies. She thus gains reputation points for acting as a mentor in this field. In return, she receives tutoring by an expert in Machine Learning and offers reputation points to her mentor. All these transactions are stored on the Blockchain, thus enabling easy transfer between units or organisations if needed and the automatic detection of any abuse of the system (e.g. pairs or small groups of employees favouring each other).

Jane is gradually building a strong portfolio in Data Science, with proof that she has gained advanced knowledge based on her earned badges, reputation points, as well as her learning activities and produced artefacts, all of which are recorded and stored in her Learning Passport. Even though she has not returned to formal education, she is now in a much better position to seek a promotion and advance her career.

## Towards a learner-centred ecosystem

We envisage a learner-centred ecosystem of educational transactions, as shown in Figure 2. Within their educational context, learners create single authored or shared artefacts with their peers. At the same time, learners are enrolled on a number of courses and are making use of additional learning resources. Tutors and other teaching staff are providing informal and formal feedback as the learners complete summative and formative assessment. Central administration bodies are issuing formal certificates according to institutional processes.

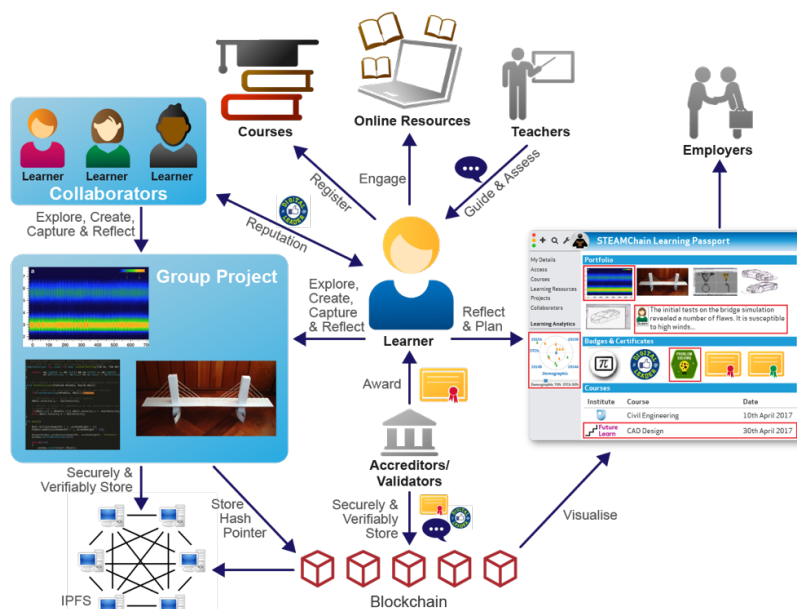


Figure 2: A learner-centred ecosystem of educational transactions.

We layer on top of these processes a reputational ecosystem with the learner at the centre. Learners can rate courses, online resources and teachers in terms of ease of understanding and attributes related to their specific learning goals. Learners can also rate each other on a range of qualities including, for example, organisational and communication skills. Our early work in applying this approach to academic reputation can be found at (Sharpley and Domingue, 2016).

All data about learners' accreditation, work, ratings, formal and informal feedback are stored within a framework where everything is verifiable via the Blockchain. Because of the associated costs, large data files are usually not stored on the Blockchain. Typically, large files are stored elsewhere (off-chain) and referenced using a cryptographic hash. The ecosystem depicted in Figure 2 uses the IPFS (Inter Planetary File System)<sup>4</sup> peer-to-peer storage system for storing the learner's documents. This solution enables the validity of a document to be checked, whilst dramatically reducing storage costs.

The following sections outline in more detail the core elements of this ecosystem. In particular, we describe how ePortfolios, accreditation and tutoring can be enhanced by Blockchain technology within this ecosystem and the new opportunities that arise for learners, educators and academic institutions.

### ePortfolios

The primary benefit brought by the Blockchain to ePortfolios is the disaggregation between the activities that learners have been engaged in and the accreditation gained. Facilitating the representation of both learner work within ePortfolios and accreditation will allow all educational stakeholders to engage in this. The use of the Blockchain also addresses the following issues:

- **Hosting and scalability** – as an issue is removed as data is copied and hosted throughout the peer network. Due to its distributed nature, the Blockchain is also resilient to scalability.
- **Ownership** – following the peer-to-peer principles of the Blockchain, there is no single data owner. Instead, ownership resides in the participating community that provides a consensual framework of control. As a consequence, all data in the ePortfolios are owned by the learners, who also control access to their ePortfolios.
- **Privacy and security** – can be provided through two main routes. Firstly, all sensitive data can be stored off-chain with parties digitally signing hashes of the data as required. Secondly, data can be encrypted with the keys held by the relevant stakeholder such as the learner.
- **Interoperability and transportability** – all data on the Blockchain are shared across the peer network and transactions are visible to all. In essence, an educational Blockchain acts as a global source of truth across the participating organisations and individuals. Therefore, the interoperability and transportability issues are solved at a data level.
- **Immutability and reliability** – are ensured as Blockchain transactions are immutable records that are signed and can be multiply signed, for example by a host institution and an individual course assessor.

### Accreditation

There is widespread concern about the need to continually upskill workers to keep pace with new technological advances and consequent new business models and industrial value chains. In the US, 60% of executives struggle to maintain appropriate workforce skills in the climate of rapid technological change and only 55% of leaders believe that the current education system can provide an adequate programme of lifelong learning and skills development.<sup>5</sup> As a result of emerging technologies, there is also a growing demand for high level digital skills in areas such as cyber-security, cloud and mobile computing and data analytics.

Transferring organisational learning to the workplace is not a straightforward process. Amongst all the factors that can affect learning transfer, feedback from peers has been shown to be a significant positive force. For example, a study of 35 academic staff members (Van den Bossche *et al.*, 2010) found that the number of staff members offering helpful feedback is positively related to the transfer of training. Additional studies indicate that gaining support from peers, as well as trainees and line managers, is incorporated into organisational training initiatives (Holton III and Baldwin, 2003).

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<sup>4</sup> <https://ipfs.io/>

<sup>5</sup> <http://www-935.ibm.com/services/us/gbs/thoughtleadership/skillsstorm/>



and payments, thus automating administrative processes and reducing overhead costs. The platform will be open for individual academics and academic institutions to join and offer their services to learners.

## Conclusions and next steps

This paper has discussed the different ways that lifelong learning is impacted by the emergence of Blockchain technology. We have presented an ecosystem that places the learner at the centre of the learning process and its associated data, with emphasis on the way ePortfolios, accreditation and tutoring are augmented with the introduction of Blockchain technology. This approach enables learners to plan their learning journey more efficiently based on their desired career trajectory and offers them full control and ownership over their learning artefacts and processes.

We are currently implementing the core components of this ecosystem, using the Ethereum Blockchain platform (Buterin, 2013). We are also working on learning scenarios and applications on real-life educational platforms, including the OpenLearn<sup>9</sup> repository of open educational resources and the FutureLearn<sup>10</sup> MOOC platform. Both of these platforms host thousands of hours of educational content, which is being studied by millions of learners worldwide. We are identifying the types of interventions that can be introduced by Blockchain technology to these platforms and we are implementing the necessary infrastructure to realise these interventions, such as a variety of smart badges and smart contracts on the Ethereum Blockchain.<sup>11</sup> We aim to test the resulting software prototypes with real learners within these platforms and evaluate them in order to better understand how our approach can impact different aspects of lifelong learning.

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<sup>9</sup> <http://www.open.edu/openlearn/>

<sup>10</sup> <https://www.futurelearn.com>

<sup>11</sup> <http://blockchain.open.ac.uk>