# Trustless Education? A Blockchain System for University Grades

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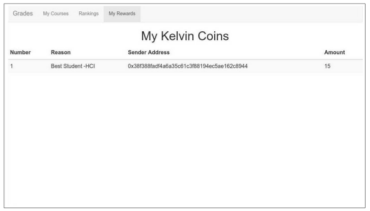
## Abstract
We have implemented a blockchain system based on Ethereum for use by a university to store student grades and to provide a cryptocurrency. Based upon an exploratory, qualitative evaluation we have found several tensions between the concept of a university as an organisation, and the concept of distributed autonomous organisations (DAOs) in Ethereum. These include tensions in (i) mechanisms of trust, (ii) boundaries of openness, (iii) values in procedures. In this paper we outline our implementation and the evaluation process.

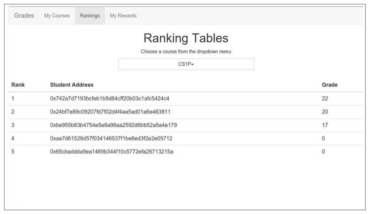
## Author Keywords
Ethereum; Blockchain; Prototype.

## ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## Introduction
With the advent of so-called Bitcoin 2.0, blockchain has outgrown its initial application area and is being used in general purpose, programmable systems. The most high profile of these is Ethereum.

Ethereum is a decentralized platform and programming language for distributed, autonomous applications [1]. Ethereum is radical because as well as data, program




Two example screenshots from the system frontend. Top is a view of "my Kelvin Coins" showing a student how many coins they have. Below is a ranking table for a course.

The problem with designing blockchain based systems is that the important concepts are 'infrastructural' rather than in the user interface. Our evaluation therefore concentrated on the ideas in the system rather than the functionality.

scripts known as smart contacts are also stored on the blockchain and executed by the nodes. Computation thus becomes distributed, transparent and verifiable. This approach is highly inefficient, but at the same time offers verifiable proof-of-execution.

Just as any person with a computer can (in theory) act as a miner of Bitcoins and thus store and contribute to the upkeep of the Bitcoin blockchain, any person with a computer can also (in theory) be a node on the Ethereum network, meaning that they can contribute to the execution and upkeep of a blockchain based computational system. Both are examples of what have become *Distributed Autonomous Organisations* (DAOs).

## The SmartCampus Blockchain System

We have designed and implemented an Ethereum based system for use by our University. This was self-motivated exploratory work to understand the potential of blockchain technology. The idea in building this system was in to gain practical and critical insight into a novel form of technology – to do research *through* design and implementation.

We chose to focus on student grades. These are at the heart of education and (arguably) should be tamper proof and permanent, and therefore seemed a reasonable focus. Our implementation had the following functions:

- The system stores student course enrollment information, their grades, and their final degree.
- The system supports a University specific cryptocurrency (which we call Kelvin Coin)
- Payments of the cryptocurrency can be automatically allocated via a smart contract to the top performing students on each course.

The system is a functional prototype with a rudimentary interface (see sidebox). It is built to demonstrate the potential of blockchain for this area rather than be a fully featured, release-grade system. Our rationale for building the system was:

- Grades become tamperproof and transparent, and therefore more 'trustworthy'.
- Awards for grades become transparent. In our system a payment is made, but a further step would be to use a smart contract to automatically award a degree classification based upon results.

By designing and evaluating the system we were able to critically address this rationale, and discover a range of complexities that were not initially obvious.

## Evaluation

Given that the project was exploratory and oriented to feasibility rather than performance, our evaluation was qualitative and intended to be generative of insight and formative within ongoing work.


Our first evaluation phase was persona based. Following Gothelf and Seiden [3] we first created "proto-personas". Two personas, a student and a prof, are pictured above. Subsequently, following Nielsen [4], we used these personas to create scenarios.

We found evaluation difficult. The system offers some basic functionality but is itself more conceptual that most software applications. What we needed to evaluate with this work was a new way of thinking about administrative university systems (as opposed to assessing whether our specific implementation met defined criteria).

More generally, we argue work on innovating blockchain systems is highly speculative engaging 'vision' and even ideology - more so than it engages typical software engineering requirements. With this in mind, we chose to evaluate the system in the following two ways:

*Scenario based evaluation*
Firstly we performed a scenario-based evaluation. This allowed us to critically engage with and expand visions of use. Drawing upon Gothelf and Siedon's [3] work, we created 'proto-personas' for student and staff stakeholders and then used these to generate scenarios. This approach was subjective, but enabled us to formulate in more detailed ways what people might want and gain from a blockchain based system and to think about what alternative ideas and desires there may be beyond our own. These also were valuable for use in explaining (difficult to understand [2]) blockchain concepts and our system to others.

*Focus group based evaluation*
Secondly we ran a small focus group (attended by two people – one professor and one researcher) to gain feedback on the work. The focus group began with a presentation of the system and the scenarios produced in the first part of the evaluation. We then asked three open-ended questions. The focus group was transcribed. Below we summarise the key themes:

BLOCKCHAIN SUITS AUDIT CULTURE
Firstly, blockchain technology was seen to fit with university audit culture. The use of a blockchain based grades store may be attractive because of its overt support for audit. However it retaining power and autonomy in doing audit rather than becoming auditable appears to be important.

GRADES ARE NOT ALGORITHMICALLY GENERATED
Secondly, however, there are some 'dark arts' in how grades and degrees are determined. Using smart contracts stored in a blockchain for calculating grades is problematic because there is not a formal algorithm for calculating them. Discretion is used, and boundaries between classifications are malleable.

REPUTATION AND TRUST ARE ENMESHED
Thirdly, Providing a future employer with access to a blockchain certificate introduces a new form of trust relationship. Blockchain technologies may be beneficial between universities if they will make the validation of different applications (such as for a PhD) easier and trustworthy. However universities use their status to engender trust, and so a blockchain might be counterproductive in that it implies that trust is based upon *external audit* rather than reputation.

OWNERSHIP AND SCOPE WOULD BE PROBLEMATIC
It is not clear if a blockchain system will belong to and be controlled by a university, or perhaps across a group of Universities, or if a public blockchain such as the one in Ethereum is suitable. Where to draw the boundaries is unclear.

A CRYPTOCURRENCY WOULD NEED TO BE STRATEGIC

When developing and issuing a cryptocurrency, the needs of the University have to be taken into account. How the university can benefit from it, not just the student, should be considered. Having a 'local cryptocurrency' that is not just usable in the University gift shop but within the local community may help the University in its community role.

UNIVERSITIES SEEK EFFICIENCY

Finally, the university may realistically adopt blockchain technology if it can save resources. Efficiency and cost reduction drives much administrative decision making. It is not our experience that blockchain technology will provide this.

## Discussion

The evaluation showed us that designing what might be assumed to be a simple, tamperproof ledger in fact runs headlong into the organizational politics of Universities. There are incompatibilities between the idea of a DAO and a University including:

- A DAO is "trustless" but a University trades on trust. The University needs to embody trust and status rather than be subject to computational methods of verification.
- A DAO has global scope but a University would probably want to set boundaries, perhaps at institutional level, or across a broader group. It is not clear where to draw boundaries or what the implications of different boundaries would be.
- A DAO prioritises transparency over efficiency, but Universities seek organizational efficiencies. They also appear to eschew algorithmic grades calculation in favour of a discretion based system, so in making calculation more transparent it necessarily (for better or worse) becomes more algorithmic.

*Evaluation challenges*

From our perspective, the most important outcomes from this work are methodological. The work reveals that there are severe challenges in designing blockchain systems for application in existing contexts. These challenges arise because Blockchains are infrastructural, something intended to underlie new ways of doing things- ways that can challenge fundamental assumptions about what an organisation is and does.

The challenges of evaluation are atypical because they are not about measurement but about envisaging new forms and logics of organisation. We believe it is design fields rather than classic software engineering methods that stand to make the greatest contribution here.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