Blockchain in Education: possibilities for a blockchain based study management system for Higher Education Institutions

A paper delivered to complete the requirements of the workshop "Blockchain, data analysis and digital change inside companies" held at the Bielefeld University of Applied Sciences from 24 to 30 September 2018.

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December 2018

Table of contents

List of Figures

1. Introduction

Blockchain as one of the emerging recent technologies with its characteristics such as trust, transparency, immutability, self-sovereignty and provenance offers alternative solutions to different problems in different industries. One of them is certainly also the education industry. There are a lot of procedures and processes in the education industry (and especially in higher education) that can be digitized. One among them is the process of issuing ECTS credits or degrees to students or showing them to a third-party institution. At the time being it takes a lot of time and energy to get all the needed papers to prove that a student's achievements are original. The most common situations, which every student can visualize are doing an exchange semester abroad and showing one's achievements to an employer. In our example the partner university wants to have all possible papers regarding ECTS credits and courses that an applicant has taken in order to be able to take a decision regarding accepting or declining an application. Or if one wants to continue their study abroad, they need to prove their achievements beforehand. In order to do this, students need to contact their home university and ask for issuing such documents. In a lot of cases this takes some time and costs in consideration.

The second simple example is proving to an employer that the achievements are original. In such a case, the employer would need to contact the home university to ask whether the issued certificate is original and whether a student has taken the courses he declares to have.

This paper aims to show some possibilities to solve such problems through blockchain. The paper does not go into very technical details of building the appropriate blockchain, but rather seeks to theoretically conceptualize a platform, which could be used by universities, students and employers to manage ECTS credits and degree certificates. This means a platform, through which the university would issue ECTS credits to students as tokens after successfully passing an exam and consequently a degree certificate after getting the needed number of credits/tokens. Students would be able to show their achievements to their potential employers or to another university through showing their public key. A case study in this paper will be the EduCTX platform, which offers a relatively well thought solution to the above-mentioned problems. This platform will be described in detail and it will also get expanded with some new ideas to make it even more suitable for the stakeholders.

This paper will start with a very brief description of blockchain and its characteristics, to continue thereafter with the possible uses of blockchain in the education industry and especially higher education. The case study/ies will follow and will also be advanced and adopted to the situation. In the last part of this paper there will be a combination of the described solutions in one hypothetical case of five universities that offer a joint degree.

This research is conducted with qualitative research methods including literature review and use cases from different actors, such as companies, start-ups or universities.

2. A short description of the Blockchain Technology

The definition that most of authors agree upon is that blockchain is a digital distributed ledger. Key advantages of Blockchain Technology are the self-sovereignty, trust, transparency and provenance, immutability, disintermediation and collaboration.[1]

In other words, blockchain makes it possible to create a decentralized environment, where the transactions and data, which are cryptographically validated, are not under control of any third-party organization. Every transaction ever completed gets recorded in a ledger that is secure, immutable, verifiable, transparent and permanent, with a time stamp and other details.[2]

The first and most famous blockchain is the Bitcoin blockchain, which exists since 2009 and was created by the still unknown Satoshi Nakamoto. Now, almost a decade later, there are many more blockchains in the market, with Ethereum being one of the most used Blockchain.

3. Possibilities of using Blockchain in education

The fields in which Blockchain could be used by Higher Education Institutions, as from an EU study identified, are award of qualifications, licensing and accreditation, management of student records, intellectual property management and payments.[3] This paper puts emphasis on two of these fields, namely on the management of student records and the award of qualifications. The possibility of permanently securing certificates in blockchains will also be further discussed together with the possibility of using verified sovereign identities for student identification within educational organizations.

These fields, where the blockchain technology can offer some innovative solutions together with the reasons for implementing blockchain-based solutions to existing situations will be discussed in the following parts of this chapter.

One thing is clear, these new solutions should offer something better for all of the included parties, otherwise it wouldn't make any sense to use them. That in mind, they should be first of all secure and trustworthy, they should be clear enough for everyone to understand and easy to use. Among other things these solutions should save costs of administration and other complications that come together. All the activities should take a shorter time to get done and should be effective on finishing their duties, with a very low chance to fail and a very high potential to improve personal data security of the involved parties. Last but not least, all these changes must be completely legal.

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[1] Grech, A. and Camilleri, A. F. (2017) Blockchain in Education. Inamorato dos Santos, A. (ed.) EUR 28778 EN; doi:10.2760/60649, p. 8.

[2] Holotescu, Carmen (2018) Understanding Blockchain Technology and how to get used to it. *Retrieved from* www.researchgate.net

[3] Grech, A. and Camilleri, A. F. (2017)

3.1 Management of student records (ECTS)

The European Credit Transfer and Accumulation System (ECTS) is in the European Union and beyond a widely recognized standard for measuring learning achievements of a student.[4] However, there is no standardization regarding storing these credits or transferring them to another Higher Education Institution (HEI) in a fast and automated way. In this part, we will limit ourselves only to ECTS credits and how these could be issued through blockchain and be stored there.

Awarding ECTS credits by the universities is the act of officially recognizing the completion of a learning unit, which contributes to achieving the intended degree. The accumulation of a certain number of credits leads to obtaining the respective degree, be it a Bachelor, Master or a PhD.

As defined from the European Commission in the "ECTS Users' Guide", the credit transfer should offer the possibility to students to have their cumulated credits in one institution recognized from another institution as contributing to the award of a degree. Universities and faculties are allowed to make agreements to guarantee automatic recognition of transfers of credits.[5] At the time being the documentation of ECTS credits is offered by the supporting documents such as Course Catalogue, Learning Agreement, Transcript of Records and Work Placement Certificate.

Blockchain Technology offers a great possibility to avoid these procedures, which in a lot of cases present an obstacle for students and additional work for the university administration.

The Higher Education Institutions which already use ECTS could award and transfer credits on a permissioned blockchain, that is specifically created for this intention.

There have already been some attempts to create such blockchains that make it possible to award ECTS credits in a blockchain. Among the analyzed platforms and projects, the most advanced and concrete idea is the EduCTX platform.[6] This platform proposes a blockchain based higher education credit and grading platform. The platform should be used from students, universities and companies (as employers) as main stakeholders. It also proposes a so called ECTX token, which would be managed, processed and controlled by the above-mentioned platform on a distributed peer-to-peer (P2P) network, where the peers (nodes) would be the Higher Education Institutions. One ECTX token should be equal to one ECTS credit. Students would hold an EduCTX blockchain wallet, where they could collect ECTX tokens (in this case the ECTS credits) from their higher education institution after completing a course. Namely, after passing a course, students would get a transfer of ECTX tokens to their wallet equal to the number of ECTS that a course offers. According to the platform proposal after such a transaction the following data would be stored on blockchain: the sender (official name of the Higher Education

[4] A list of 48 countries that already use ECTS can be found under the following link: http://www.ehea.info (Last visit on 28.11.2018)

[5] ECTS Users' Guide. Page 12. Downloaded from: https://publications.europa.eu/en/publication-detail/-/publication/da7467e6-8450-11e5-b8b7-01aa75ed71a1

[6] Turkanović, Muhamed & Hölbl, Marko & Košič, Kristjan & Hericko, Marjan & Kamisalic, Aida. (2017). EduCTX: A blockchain-based higher education credit platform. IEEE Access. PP. 10.1109/ACCESS.2018.2789929.

Institution), the receiver – student (anonymously presented), token (credit value of a course) and course identification.

Such a transaction would look like the following example:

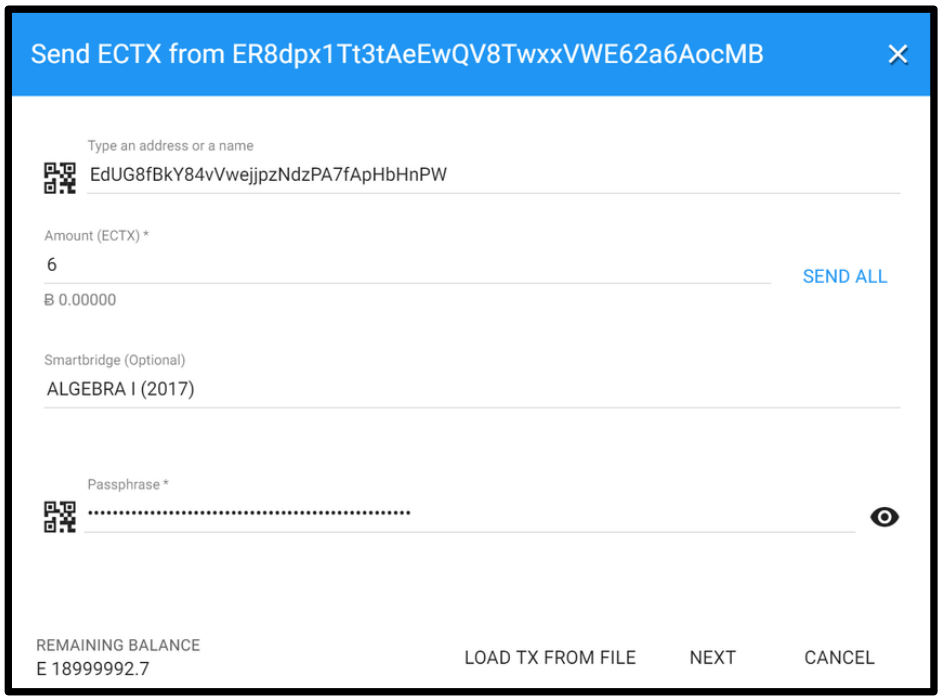


Fig. 1 Example of issuing ECTX to a student[7]

In this way a student as the receiver of ECTX tokens would be able to prove the completed courses by presenting their blockchain address. Due to security sensibility, the EduCTX platform proposes that students would be assigned a 2-2 multisignature address by their home university, so they would be able only to receive tokens, but not to transfer them to another address. The process of awarding ECTX to students and the possibility to prove their possession, according to the platform proposal, would be able through an EduCTX blockchain API client.

As mentioned above the Higher Education Institutions (HEIs) would act as nodes, which means that while joining the network a new HEI would have to set up a network node. Since not every random institution can join the network, member HEIs decide whether to accept a new HEI as a node or not after reviewing its application. An advantage of the EduCTX platform proposal is that there is no need to mine transactions and thus no computing power is needed. The proposed consensus protocol is **delegated-proof-of-stake** (DPoS), which gives the right to a node (HEI) to confirm transactions and seal blocs after being voted by other nodes as a delegate. So, the community will vote for a delegate and give the right to seal new blocks.[8] The forging reward should be lowered to zero in order to keep the platform and the community democratic and non-profit.

[7] Researchgate: https://www.researchgate.net/figure/Professor-assigning-credits-using-the-ECTX-client-wallet_fig4_320707539 (Last visit on 29.11.2018)

[8] Turkanović, Muhamed & Hölbl, Marko & Košič, Kristjan & Hericko, Marjan & Kamisalic, Aida. (2017). EduCTX: A blockchain-based higher education credit platform. IEEE Access. PP. 10.1109/ACCESS.2018.2789929. Page 5116.

An overview of the EduCTX platform is presented in the following graphic:

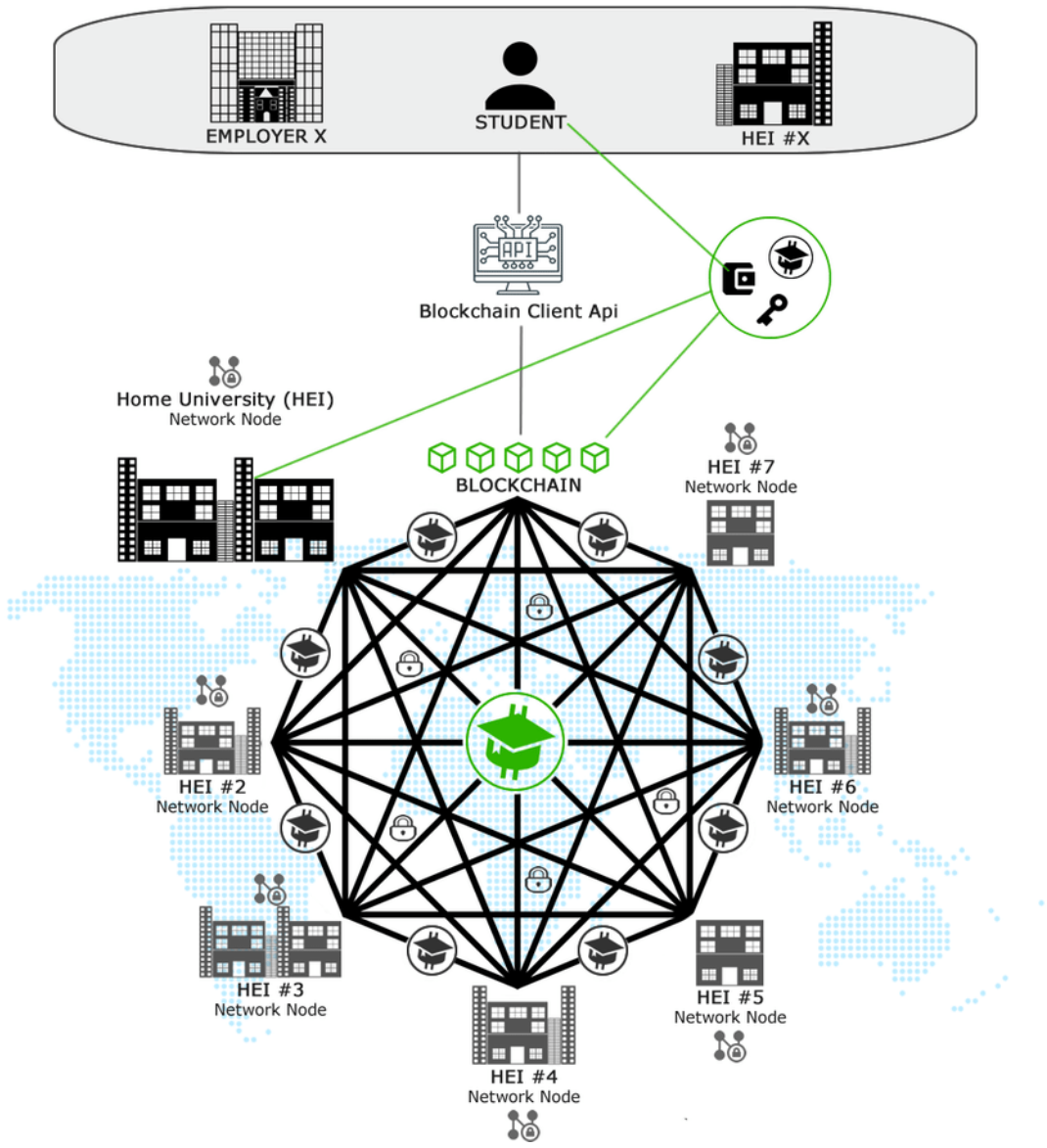


Fig. 2 Structure of the EduCTX platform and its stakeholders[9]

The process of a student's credit verification by an organization, be it a university or a potential employer (a company) is clearly described and it does not include any risk of data misuse from not authorized parties. As the authors of the EduCTX platform explain, when an organization needs to verify the educational achievements of a student, the student must first send his/her blockchain address, his 2-2 multisignature and his/her redeem script to the verifying organization (university or company). They would then check it by using a blockchain web API to access the data (in this case the ECTS credits and the related courses). In order to ensure that the student is really using his/her blockchain address, the

[9] ResearchGate: https://www.researchgate.net/figure/A-high-level-depiction-of-the-proposed-EduCTX-platform_fig1_320707539 (Last visit on 29.11.2018)

verifying organization sends a private message to the student, which he/she should sign with their private key.[10] The following BPMN process gives more details to this plan:

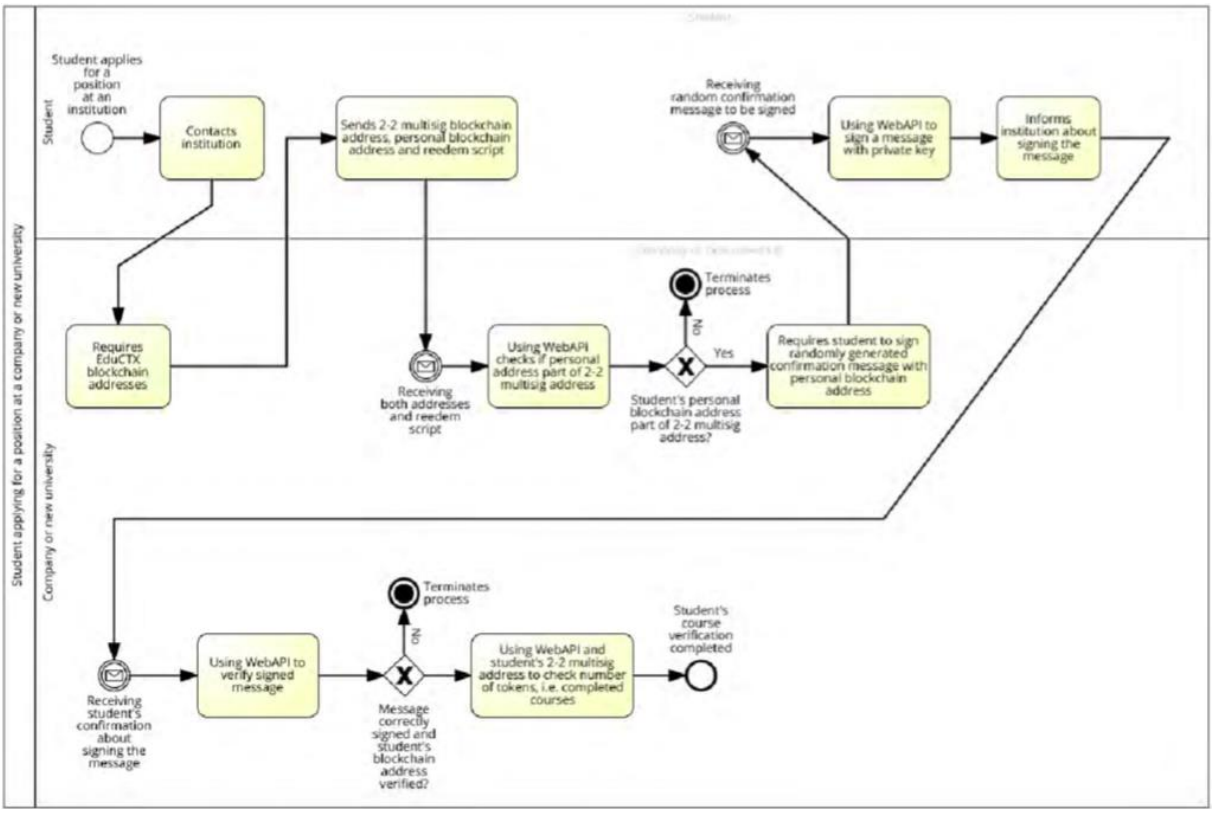


Fig. 3 The process of the verification of a student's educational achievements[11]

EduCTX platform is of course not the only platform that deals with storing and securing of educational data on blockchains but is one of the main platforms that deals precisely with the issue of granting, storing a proving possession of ECTS credits. Another platform for storing and tracking of educational records has been presented by Sony Global Education,[12] but it neither deals precisely with higher education nor with the ECTS credits.

Based on the information provided in this section one can say that EduCTX presents a realistic approach to the issue of awarding ECTS to students by Higher Education Institutions. The implementation of this idea seems to be completely possible as presented from the authors of the platform, who already created a prototype implementation. However, in the next sections we will check the possibilities to expand the idea of the EduCTX platform with additional services, like generating blockchain-based degrees and securing these in blockchain.

[10] Turkanović, Muhamed & Hölbl, Marko & Košič, Kristjan & Hericko, Marjan & Kamisalic, Aida. (2017). EduCTX: A blockchain-based higher education credit platform. IEEE Access. PP. 10.1109/ACCESS.2018.2789929. Page 5119.
[11] ResearchGate website
[12] Sony Global Education https://blockchain.sonyged.com/ (Last visit on 29.11.2019)

3.2 Award of qualifications

After discussing the possibilities of assigning and storing ECTS on blockchains now we will consider the possibility of issuing certificates on blockchain.

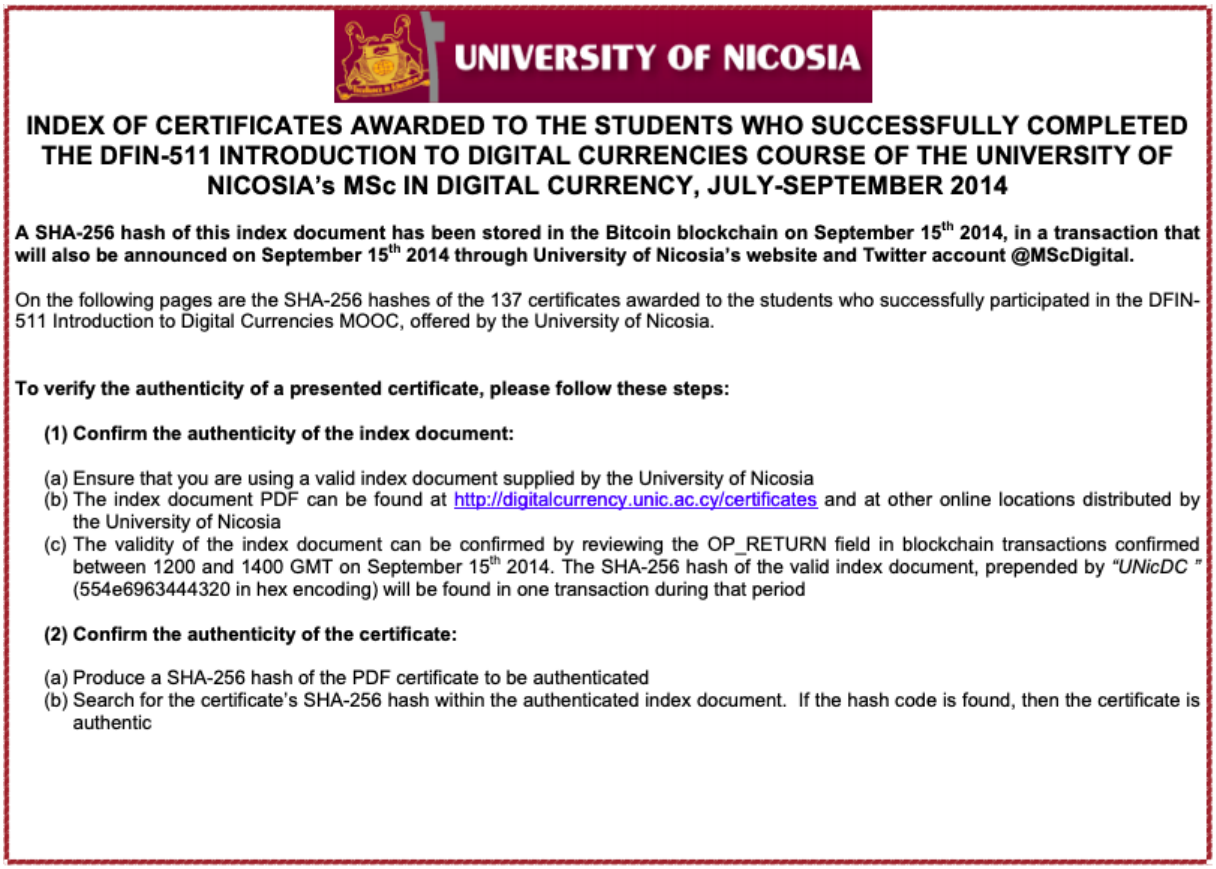
Learn agreements between universities can also be written as smart contracts, and at the point of fulfillment of the criteria credits would be automatically transferred. Also, for accumulation this could be possible, when a certain number of credits is achieved, the smart contract would automatically issue the degree (equality among all the cases).[13]

As identified by Bartolomé (2017) there are two cases, where Higher Education Institutions are engaged, which have brought to life the award of certificates in blockchains.[14] The first one is the University of Nicosia in Cyprus, which offers already some accredited courses with verifiable certificates on blockchain.[15] The University of Nicosia offered the first university course on the topic of cryptocurrency *DFIN-511 Introduction to Digital Currency* in 2014 and stored the completion and participation certificates in the Bitcoin blockchain. What they did was not actually storing the certificates itself in the Bitcoin blockchain but the hashes of these certificates. They did not store the hashes of each student alone, but the hash of an index document with all hashes of certificates issued in a term for this one course in it. This was on one side reasoned with the fact that storing was not completely free, since every input would be considered as one transaction, and on the other side with the fact that the hashes would be safer and easier to verify if they were stored together. The reason why hashes are stored in the blockchain and not the certificates is firstly because hashes take much less space than the PDF documents of the certificates and secondly it is only possible to recreate the hash from the PDF document and not the other way around. Through a SHA-256 algorithm one could always create the hash of a PDF document. From the same document comes out the same hash every time. So, if we want to verify a certificate, we create the hash of the PDF version of the certificate and if we find this hash in the list of certificate hashes from the University of Nicosia we know that the certificate is original. As explained by the issuer of these certificates, detailed instructions would be included into the certificate, like the hash of the index document where all the hashes are included and the hash of the certificate itself. Actually, only the hash of the index document is stored in the Bitcoin blockchain. An example of how an index document looks like is shown in the following figure. The figure shows only the first page where some instructions and other details are listed. In the following pages there is a list of all hashes of the issued certificates of accomplishment and participation in the course mentioned in the figure.

[13] Grech, A. and Camilleri, A. F. (2017) Blockchain in Education. Inamorato dos Santos, A. (ed.) EUR 28778 EN; doi:10.2760/60649, p. 97.

[14] Bartolomé, Antonio & Bellver, Carles & Castañeda, Linda & Adell, Jordi (2017) Blockchain in Eduacation: Introduction and critical Review of the State of the Art. EDUTEC.Revista Electrónica de Tecnología Educativa Nr. 61. Page 6.

[15] Webpage of the University of Nicosia, where examples of certificates can be seen: https://digitalcurrency.unic.ac.cy/free-introductory-mooc/self-verifiable-certificates-on-the-bitcoin-blockchain/academic-certificates-on-the-blockchain/



UNIVERSITY OF NICOSIA

INDEX OF CERTIFICATES AWARDED TO THE STUDENTS WHO SUCCESSFULLY COMPLETED THE DFIN-511 INTRODUCTION TO DIGITAL CURRENCIES COURSE OF THE UNIVERSITY OF NICOSIA's MSc IN DIGITAL CURRENCY, JULY-SEPTEMBER 2014

A SHA-256 hash of this index document has been stored in the Bitcoin blockchain on September 15th 2014, in a transaction that will also be announced on September 15th 2014 through University of Nicosia's website and Twitter account @MScDigital.

On the following pages are the SHA-256 hashes of the 137 certificates awarded to the students who successfully participated in the DFIN-511 Introduction to Digital Currencies MOOC, offered by the University of Nicosia.

To verify the authenticity of a presented certificate, please follow these steps:

(1) Confirm the authenticity of the index document:

(a) Ensure that you are using a valid index document supplied by the University of Nicosia
(b) The index document PDF can be found at http://digitalcurrency.unic.ac.cy/certificates and at other online locations distributed by the University of Nicosia
(c) The validity of the index document can be confirmed by reviewing the OP_RETURN field in blockchain transactions confirmed between 1200 and 1400 GMT on September 15th 2014. The SHA-256 hash of the valid index document, prepended by *"UNicDC "* (554e6963444320 in hex encoding) will be found in one transaction during that period

(2) Confirm the authenticity of the certificate:

(a) Produce a SHA-256 hash of the PDF certificate to be authenticated
(b) Search for the certificate's SHA-256 hash within the authenticated index document. If the hash code is found, then the certificate is authentic

Fig. 4 A sample certificate from the University of Nicosia[16]

Within the frames of this paper I tried the verification process of a random certificate from the University of Nicosia using a hash. I could find out that in this way the verification would cost 0,00025 BTC (Bitcoin) that equals 0,81€ (at a BTC price of 3230,57€ on 05. Dec. 2018). There are two possibilities to verify certificates: either using a hash or using a PDF document (by drag and drop).

Fig. 5 The process of a certificate verification on Bitcoin blockchain.[17]

[16] University of Nicosia website: www.digitalcurrency.unic.ac.cy
[17] Proof of Existence webpage: www.proofofexistence.com

The second use case is the Blockcerts project from the Massachusetts Institute of Technology (MIT), which takes the form of a platform and standards that enable institutions to implement blockchain in educational programs.[18] As Bartolomé claims, Blockcerts includes four basic components: **the issuer** – the institution issuing the digital certificate, **certificates** – which contain certain statements regarding achievements, skills or other characteristics of a student, **verifier** – someone who verifies that the certificate is original and not altered and all this without any help from the issuer and the **wallet** – where the certificates are stored and can be shared with another university or employer.

These four components are visualized in the following graphic, where the issuer is a school, the recipient is a student and the verifier is an employer.

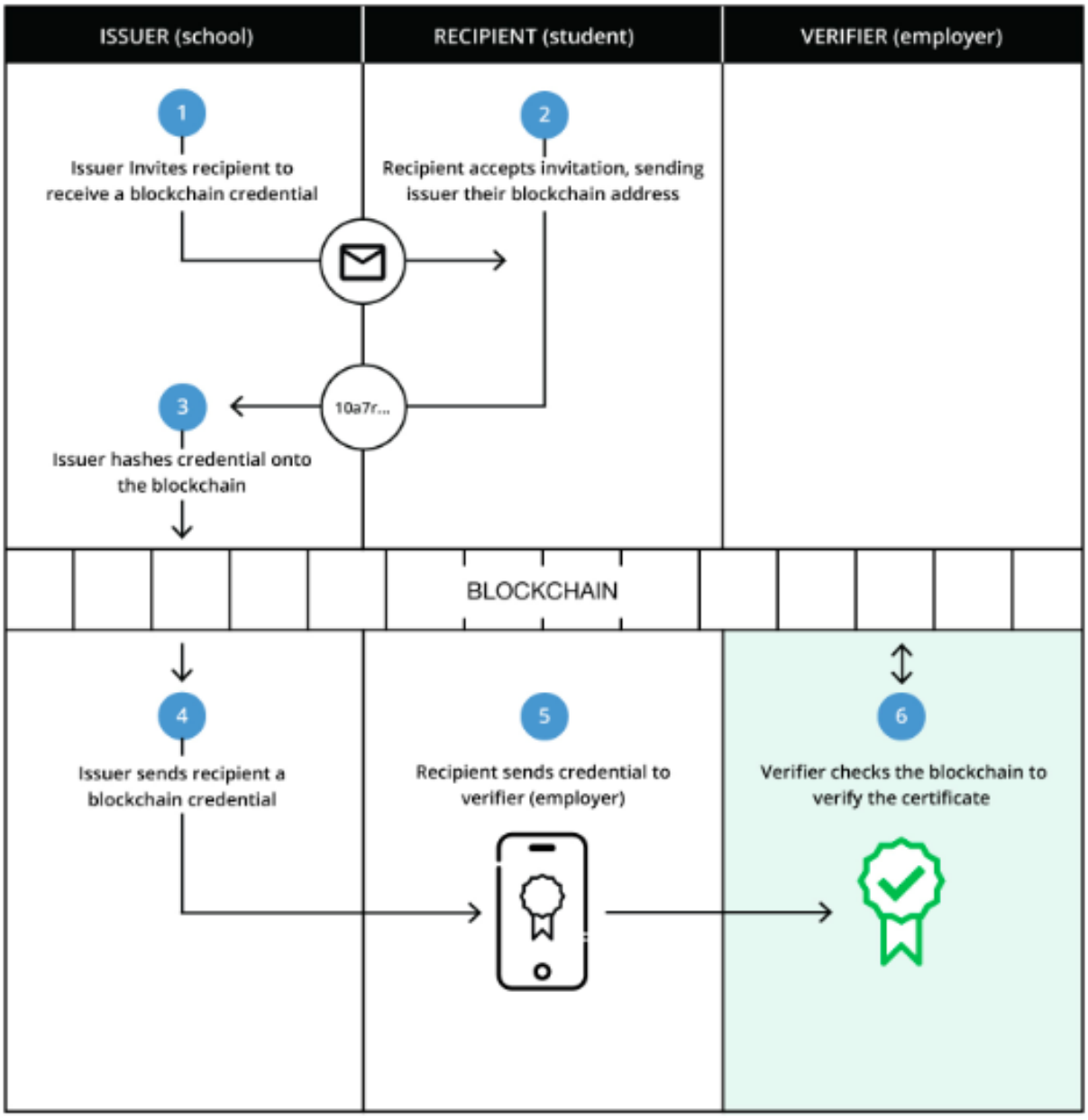


Fig. 6 How Blockcerts' certificate issuance and verification work.[19]

[18] Bartolomé, Antonio & Bellver, Carles & Castañeda, Linda & Adell, Jordi (2017) Blockchain in Eduacation: Introduction and critical Review of the State of the Art. EDUTEC.Revista Electrónica de Tecnología Educativa Nr. 61. Page 6.
[19] Blockcerts website: https://www.blockcerts.org/guide/

Differently from the use case of the University of Nicosia the Blockcerts operates with Bitcoin und Ethereum blockchains. However, the development continues to make it available to work across any blockchain including the private ones. Blockcerts is not restricted to only issuing and verifying academic certificates, but is rather an open standard for building apps that issue and verify blockchain-based official records, be it licenses, academic credentials, civic records, etc.[20]

Blockcerts offers the possibility to create, issue and view the issued certificates in test modes, meaning without spending any Bitcoin for the transaction fees, which are similar with the ones shown in Fig. 6. Blockcerts functions also with a wallet app called "Blockcerts Wallet" which is already downloadable for iOS and Android.

After analyzing these two platforms we could already see that it is possible to issue and verify certificates in blockchain. We could also see that security and immutability of the issued certificates is offered. However, there are issues related to the blockchains and the use of energy and computing capacity, which may not go in the same line with the sustainability goals.

In the next part we will discuss the issue of identity sovereignty and the possibility of using blockchain to offer sovereignty over personal data for students as our main target group.

3.3 Sovereignty over personal identity (Self-Sovereign Identity)

Creating a self-sovereign identity in the Higher Education Institutions is possible if the data gets stored by a trusted party (like the admissions office). In our case with students and Higher Education Institutions as main stakeholders this would mean that a student applies to a university and during the process he/she shows all the needed documents in original or trusted copies. In the case of admission, the university can store all the students data and issue a biometric or a similar kind of identity, which a student could use to identify him-/herself everywhere within the university and related organizations. This would reduce the number of people who have access to the students' personal data, which would contribute to make students' personal data safer.

The issue of self-sovereign identity has already been addressed by different platforms such as the Sovrin platform[21], IBM[22], or StudyBits[23]. Sovrin claims to be the first blockchain designed only for identity and "the first global public utility exclusively for self-sovereign identity and verifiable claims".[24] The Sovrin platform deals generally with the issue of identity in the "online world" and offers solutions based on blockchain technology. Similar is also the idea from IBM, where a decentralized public key infrastructure is proposed as a solution to facilitate the self-sovereign identity through

[20] Blockcerts website: https://www.blockcerts.org/guide/
[21] Sovrin website: https://sovrin.org/
[22] IBM: https://www.ibm.com/blogs/blockchain/2018/06/self-sovereign-identity-why-blockchain/
[23] BCinED StudyBits: https://www.bcined.com/studybits.html
[24] White Paper „Sovrin: A Protocol and Token for Self-Sovereign Identity and Decentralized Trust" Page 15. *Retrieved from:* https://sovrin.org/

blockchain technology. From the three mentioned platforms only the StudyBits project deals directly with the application of self-sovereign identity in education. However, StudyBits uses the Sovrin Blockchain as a technology for its solutions. The StudyBits project intends to digitalize the exchange of student information between universities and other institutions using blockchain related technologies. The pilot project tends to test the blockchain based solution with 20 Students and four universities (Groningen, Ghent, Uppsala and Göttingen). The target group of students will participate in the Erasmus+ Exchange program and if they'll be able to prove their credentials to the receiving institution through blockchain the project will be considered as successful and promising for future innovation in the field of education.[25]

As seen in this short discussion, there are technical solutions to the most of problems in the field of education related to the management of student records, award of qualifications and self-sovereign identity. Why the implementation of blockchain technologies in education is going so slow and taking so long could be a further research topic. In the next section we will try to find and shortly analyze a few complications that would accompany the application of blockchain technologies in education.

4. Possible complications of using blockchain in higher education

A broad application of blockchain technologies in education would surely bring up different kinds of questions and complications since this technology is new and there are not many use cases to learn from. Most of the projects are in a pilot phase and have not proven themselves as sustainable yet.

As Bartolomé considers, it would be unrealistic to think that the application of blockchain technology in education is something that will happen immediately or that the changes will be implemented in the coming years. He even asks the question of what the ideology and the agenda of institutions and enterprises trying to apply blockchain in education is.[26] Most of the criticism to the blockchain application in education is related to the nature of blockchain as a decentralized ledger and its lack of institutional regulation. Despite that, Watters mentions also the invocation of trust mediated by technology as a big problem, since it represents a key social behavior.[27]

Other criticism comes from the idea that blockchain is supposed to be used only by the cryptocurrencies and in this way its application will make also education based on transactions, which would commercialize the industry even more. The fact that the technology is still in an experimental stage brings up another reason for sceptics of this technology not to trust in it. Also other topics such as privacy and mediation of traditionally social tasks through technology are topics of concern.

[25] BCinED: https://www.bcined.com/studybits.html

[26] Bartolomé, Antonio & Bellver, Carles & Castañeda, Linda & Adell, Jordi (2017) Blockchain in Eduacation: Introduction and critical Review of the State of the Art. EDUTEC.Revista Electrónica de Tecnología Educativa Nr. 61. Page 6.

[27] Watters, Audrey (2016) The Blockchain for Education: An Introduction. Retrieved from: http://hackeducation.com/2016/04/07/blockchain-education-guide

However, a part of this criticism is based, but as said, this technology is evolving and getting better. Every week or even every day there are new contributions to the blockchain technology with new solutions and ideas, so even the latest research does not include everything there is.

5. Imagining a "Blockchain University"

After having discussed the possibilities how blockchain could be used in education and also the potential criticism to it, now there will be a try to theoretically implement a combination of the solutions discussed in this paper to a potential situation, where five universities (internationally based) offer a joint degree program and want to use blockchain as their "administration technology" of the joint program. For this joint degree students would be able to take the same courses (or modules with different course choices) in any of the five partner universities.

The partner universities would act as nodes in a blockchain created especially for this intention. It would also be possible to get new members if the existing partners agree to it.

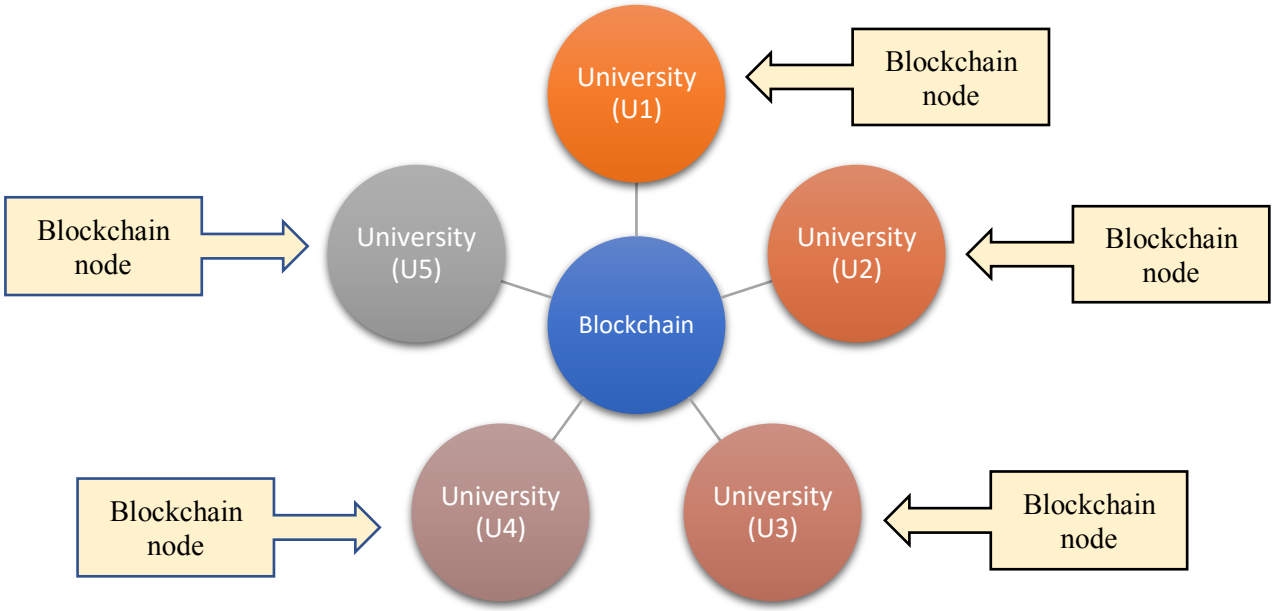


Fig. 7 Illustration of nodes on such a Blockchain.

Enrolled students would once give their data to the admission office of their home university, which would verify these and then issue a public and private key to the student, through which he/she could identify himself/herself at their home university and other partner universities without having to send their personal data. The public and the private keys would be stored in the above mentioned blockchain. Students would be able to create their wallets and receive their ECTS credits as tokens as explained earlier in this paper (see 3.1). The following simplified process shows in broad lines how this could function.

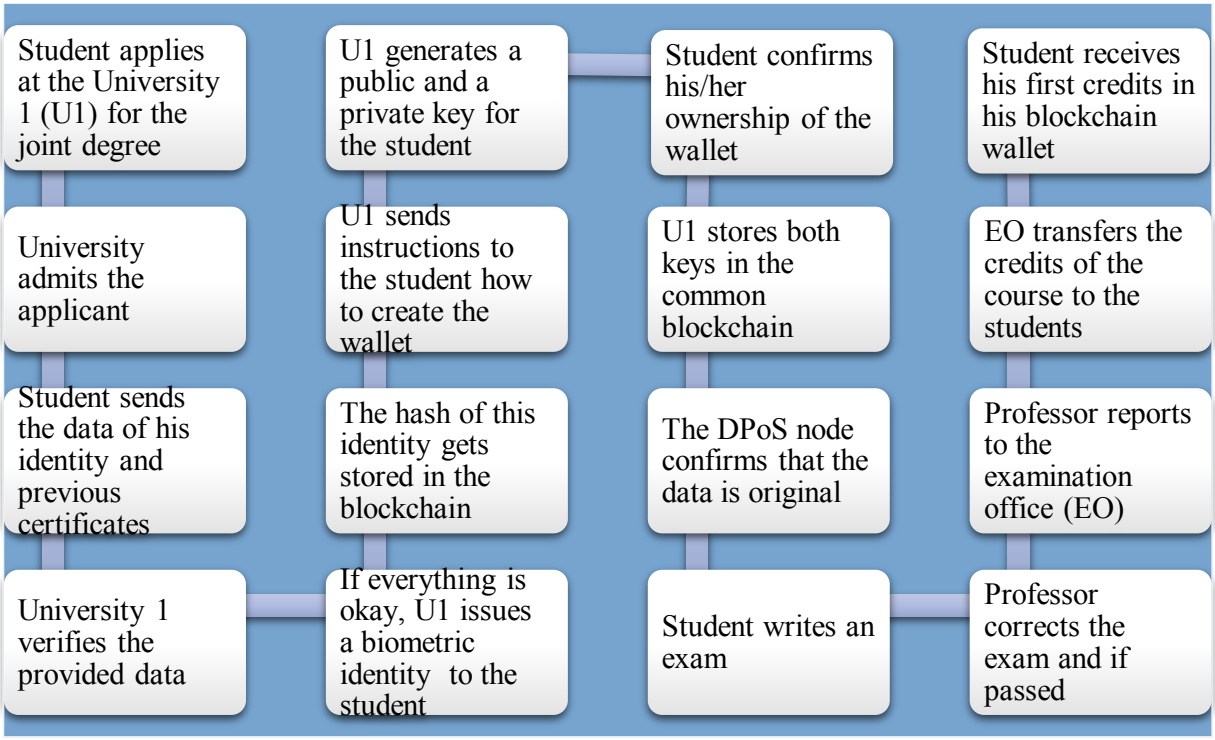


Fig 8. Process of matriculation at the university until receiving ECTS credits through blockchain

Learning agreements between partner universities would be written as smart contracts. The following graph shows the relation between universities within the Blockchain. Every university would have learning agreement with all member universities, of course as smart contracts.

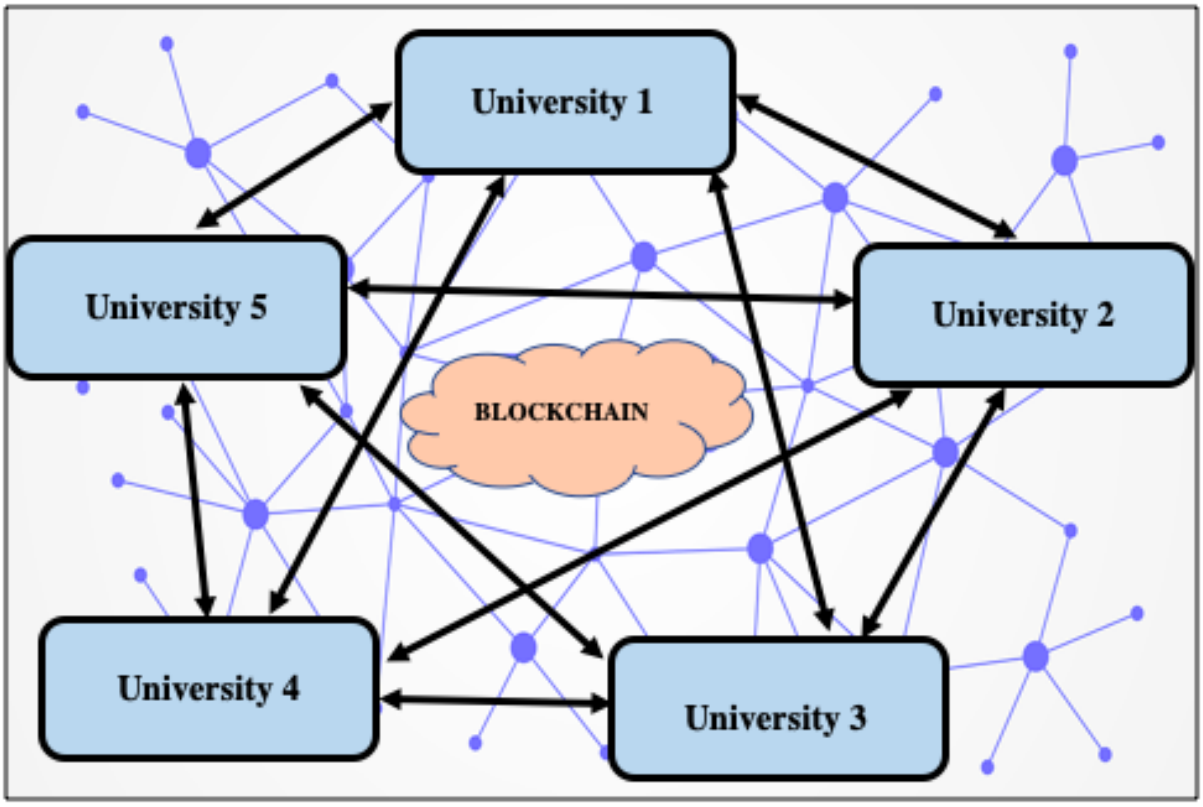


Fig. 9 Relations between university nodes inside the Blockchain (smart contracts)

Students would be able to switch between partner universities without any problem and still have their ECTS credits immediately recognized by their home university as soon as they have been issued from the issuing partner university. The following process shows the way it could work for a student to make a semester abroad a get his/her ECTS credits.

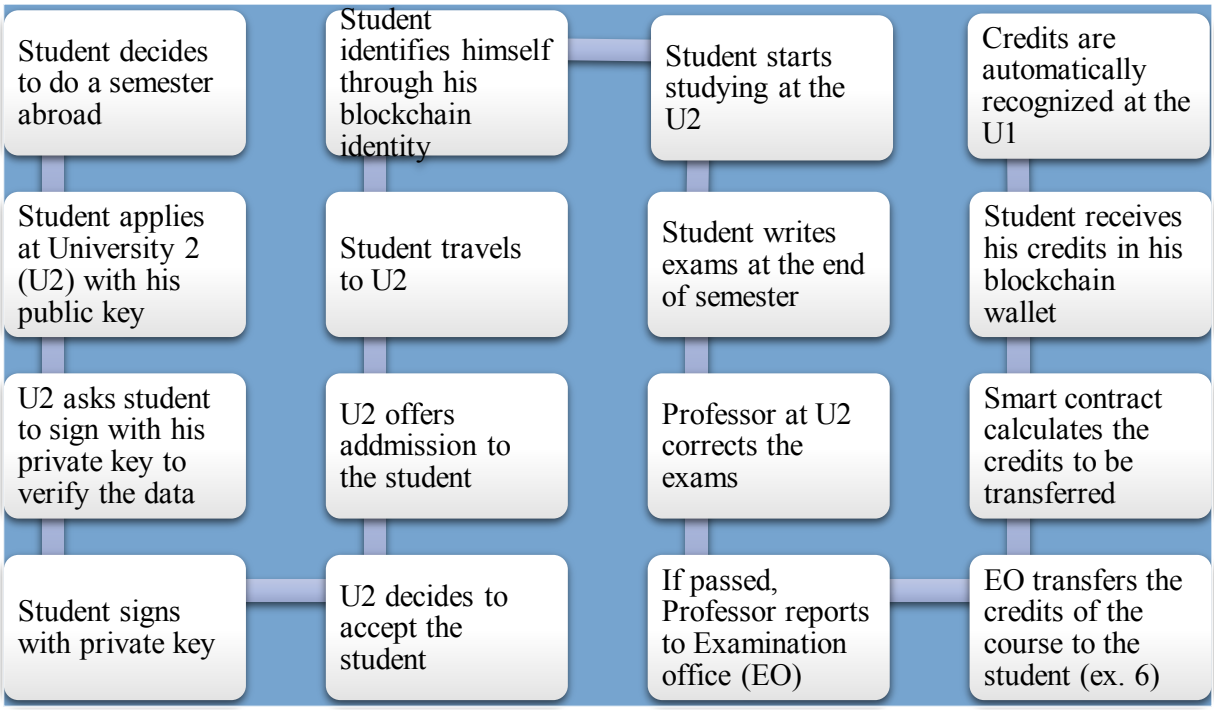


Fig. 10 The process of doing an exchange semester at a partner university

This would be a private (permissioned) blockchain, where universities would act as peers (nodes) and would have proper amounts of tokens to transfer to students. Students would only have the possibility to receive tokens/ECTS but not to forward them to other people. This would function through a wallet, which could be used by students on their smartphones or other electronic devices. They could always be able to see their credits and show them to an interested third-party.

After fulfillment of certain criteria, including the needed number of ECTS credits and other conditions set by universities individually, a smart contract would be executed, and a degree certificate would be issued to the student. Since the hash of the degree would be stored in blockchain, the certificate would be immutable und verifiable from any interested third party (another university or an employer) through a blockchain API client. However, the student, as the owner of the certificate could be able to decide for whom he makes the certificate available. The home universities could additionally issue these certificates also as electronic certificates or paper ones, based on their needs or legal obligations.

The implementation of this idea is of course not an easy job since these services have until now been offered only as single services in different blockchains.

Despite the EduCTX platform, all other introduced solutions in this paper are based on public blockchains. To implement the above described idea a permissioned blockchain is needed, as described in the EduCTX example. There are different reasons for that. The blockchain for this platform of

universities should not be a public blockchain because of the computing capacity that is related to it and the energy usage. The number of nodes is limited and therefore not everyone should be allowed to make changes to the blockchain. In a permissioned blockchain the transactions can be made without any costs and blocks can be sealed by a node based on Delegated Proof of Stake consensus protocol, where nodes vote who is allowed to seal new blocks for a certain period of time. The member universities in the blockchain can decide to take new members to the community. The profits of such a platform would be the following:

- issuing ECTS credits to students would be faster and less complicated
- students wouldn't need to get transcripts of records since they would always have their credits in their wallets and could show these to the interested third parties
- student records would be immutable and transparent in blockchain
- students' personal data would be safer and stored only once
- exchange semesters would be much easier for students and also for universities (universities would have almost nothing to do since learning agreements would be automatic and students could identify themselves with their self-sovereign identity)
- students' credits from partner universities would be automatically calculated and recognized based on smart contracts
- through blockchain and smart contracts money and bureaucratic work could be saved
- there would be almost no need for personal communication between staff of universities since the complete process would be automated
- language barriers would be eliminated (at least for the administration)
- university administration would act more as a supervisor of the process than doing the work itself.

6. Conclusion

This paper has shown once more that there is place for further digitalization in the Higher Education Industry. The proposed solutions in this paper are only a few of many solutions that already exist. However, as it could be seen most of the introduced solutions offer solutions to a part of the problem and do not treat the complete process as one. In my opinion, a solution that brings together the ideas of the already existing "part-solutions" or even some new ideas could really make a revolution in the digitalization of Higher Education. Higher Education should play its role in advancing the society and designing the future. And as almost everyone would agree, the future will not bring less digitalization, but certainly more and the Higher Education Industry should get prepared for that, not only by teaching it but also by applying it. Blockchain technology offers reasonable solutions to different problems in different industries. Among them is Higher Education a player with very big potential.

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