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Studentchain: Digitizing and Authenticating Student Portfolios using Decentralization

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Abstract: Education is a sector where the introduction of blockchain will bring a revolution to the way any organization perceives trust factor in the ecosystem. StudentChain is a pilot project for implementing blockchain ecosystem at the Institute level for Student Portfolio Management. The documents of students that they generate in their educational phase are approved by colleges before they are handed over to them. We can shift this process over to blockchain and capture these documents using Ethereum Network for data related storage and by using IPFS for file related storage. A Digital Signature by the appropriate authorities added after proof of consensus by means of biometrics will enhance the trust level among the stakeholders of the ecosystem.

Index Terms: Blockchain, education, IPFS, cryptography, contracts, consensus, ethereum, decentralization, recommendation

1 Introduction

Education is a sector which has lots of areas that could be improved using technology. The market for the edtech industry is growing considerably, and it is predicted to reach $93.76 billion in the following years globally [1]. A blockchain is a growing list of records, in an informal sense, called blocks, which are connected using cryptography. Each block stores a cryptographic hash of the block before it, some transaction data and the timestamp.

Blockchain technology in the education sector brings forth the advantage of making it possible to dematerialize documents. It can also aid in avoiding the risk of losing or falsification of documents. Higher education, academic certificates and course certificates are prone to getting lost as they have hard copies. If all this data is stored onto the blockchain, there would be no possibility of losing the information and the documents. Also, the data can be shared with others with the owner's consent. Uploading information from educational documents onto the blockchain would remove the uncertainty for employers about an employee's level of knowledge. Also, if blockchain is used, storing information about one's education would make faking a diploma impossible.

Generic methods of document submissions like photocopies and pdfs are most prone to manipulation and thus require more amount of manual work to verify & attest them. External Authorities cannot verify the student portfolio except believing in photocopies or directly contacting the college as existing solutions for verifying the integrity are slow, expensive, and inefficient. The cost wasted over paperwork and the manpower wastage for repetitive tasks can be saved considerably by using such a platform.

1.1 Features of Blockchain

1. **Immutability**: Records cannot be tampered with once committed to the shared ledger, thereby making all information trustworthy.
2. **Consensus**: A transaction is committed only when all the parties agree to a network verified transaction.
3. **Transparency/Cost & Time Saving**: Entire student portfolio is available, and External Entity can verify the authenticity saving their time and cost
4. **Redundancy control**: Repetitive tedious tasks can be avoided by storing approval and verification statuses which persists on the blockchain secured by cryptography.

2 Motivation and Related Works

A. Mikroyannidis, J. Domingue, M. Bachler, and K. Quick, in their paper "Smart Blockchain Badges for Data Science Education" have proposed applications of Smart Blockchain Badges on data science education [2]. They have investigated that Blockchain Badges supports learners to pursue their careers in data science and gives them suggestions based on their achievements. It provides learners with a transparent accreditation system and also they receive job recommendations that match their skills and help them to get success in their career. In order to facilitate accreditation and offer personalized recommendations to learners that study data science courses, they have developed and deployed infrastructure for Smart Blockchain Badges.

Learners who are interested to study various data science subjects earn badges upon reaching a certain level in their studies, for e.g. completing part of a course or a whole course. These badges are stored on the Blockchain and it includes data about the key skills that learners have gained upon obtaining these badges. Learners continue to earn badges along with that they also start receiving automated recommendations for the latest job offers that match their skills.

Another similar work in this field has been done by Bin Duan, Ying Zhong in their paper "Education application of blockchain technology: learning outcome and meta-diploma" stating about education blockchain technology based on learning outcome [3]. According to the "Washington Agreement", the graduation requirements index of the university which has passed professional accreditation are combined and corresponding points of all courses are determined which is taken as the consensus of the education blockchain, the combination of a qualitative and quantitative assessment of students' grades, evidence and learning process, is achieved. The name of the ability, the name, of course, the weight of course, and the achievement of the course are recorded as data in the block, which make it possible to transform students' course achievement evaluation of academic grades in traditional into capability index evaluation results.

Bin Wu,Yinsheng Li in their paper "Design of Evaluation System for Digital Education Operational Skill Competition Based on Blockchain" have proposed that if students are allowed to simulate games and operations on a digital education operation system then it will help schools to inspect teaching quality and learning achievement [4]. They have used blockchain technology in this digital education area to improve competition mode. They find it helpful as it simplifies processes, avoids problems of opaque messages, and improves efficiency. It also provides an unchangeable digital certification of academic achievement. The authors have studied competition mode based on blockchain technology and have also analyzed evaluation criteria and algorithm and based on that they have designed blockchain's application mode and frame, and developed an operational skill competition evaluation system based on e-business sandbox and experimented it.

X. Gong, X. Liu, S. Jing, G. Xiong and J. Zhou in their paper "Parallel-Education-Blockchain Driven Smart Education: Challenges and Issues" have proposed Parallel Intelligence and Blockchain theory [5]. They found out some problems which include the difficulty to experiment, difficult to model and difficult to optimize in the education blockchain which needs to be solved, and application scenarios, driving mechanisms, and other issues need additional analysis. They believe that education blockchain driven smart education has become the center of attention, and similar system frameworks and key technologies are presented. They, therefore, introduced a solution that caters to education blockchain, challenges, and issues, then based on the introduction of parallel intelligence theory and parallel blockchain, they proposed parallel education blockchain, its driven mechanism, application scenarios, function distribution, and data transfer. They introduced the Functional model of Whole Education blockchain which consists of three layers. It includes a data layer, logic layer, and application layer, corresponding to the educational process, evaluation process, and application process of smart education.

The data layer provides a distributed + central dual storage mechanism for educational big data which is generated by formal and informal education. The logic layer provides a dual mechanism based on consensus and non-consensus mechanisms for evaluation of certificates, credit recognition, grade certification, and certificate recognition in education. The application layer provides smart contracts for "various transactions" for formal education and informal education, such as credit transferring, grade transferring and creativity transferring.

3 Tools

StudentChain would use a peer-to-peer (P2P) network and digital ledger of all transactions providing an incorruptible and immutable audit trail that eliminates counterfeiting in certifications. It utilizes smart contracts to encrypt and issue certificates on the Ethereum Blockchain safely. Students are provided with a unique ID via a secure and seamless Easy to use SaaS web and mobile platforms. They can share these UID with job providers to verify their portfolio. Employers can access the issued certificates without any intervention from the certificate publisher or any entity.

3.1 Abbreviations and Acronyms

- UID - refers to a unique ID assigned to every student to identify their documents uniquely.
- Stakeholders - refers to members of the system holding the rights to approve a document of the student
- Approval - refers to an action by a registered user of the system who wishes to get his document approved by the stakeholders. The workflow can consist of the user signing up for the system by submitting his relevant data, such that his vault can be created; and then using his UID to submit documents and sending it for consensus-based approval.

- Consensus - refers to the majority of the assigned stakeholders approving the document of the student. Here, we have used PoA (Proof Of Authority) Consensus mechanism, where only entities who have proven their authority have a say in the decision.

3.2 High-Level Design

Fig.1. High-Level Design with Technology Interfaces

Figure 1 shows the various technologies of our system and their interfacing with the other technologies.

- IPFS for file reliable storage system as soft copy few documents need to be stored in system
- Ethereum platform for Ledger (Blockchain). This enables secure locker based storage of data.
- Metamask Wallet for ether coins to be used as transactional cost. Read is free, write costs gas.
- Nodejs based web application for stakeholders to approve data to be added on a students' portfolio.
- Truffle based application for the user for contract request generation and benefit application

3.3 Interplanetary File System(IPFS) and Metamask

The Interplanetary File System (IPFS) is a peer-to-peer network for storage and sharing of data in a distributed file system. Figure 2 shows the IPFS dashboard on initiating a connection with the IPFS network. It identifies every peer in the network with a peer-id.

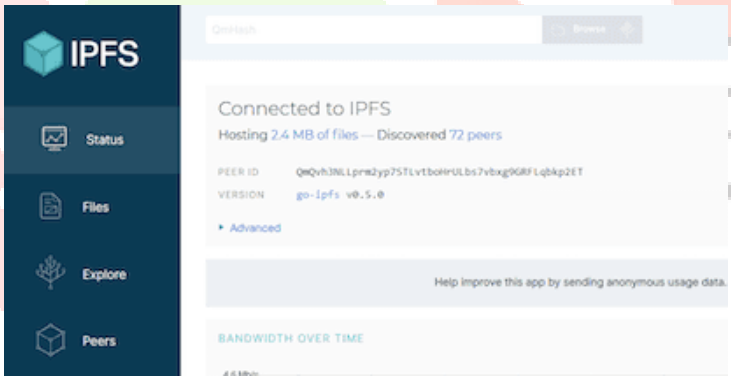

Fig.2. IPFS Dashboard

IPFS uses the phenomenon of content-addressing to uniquely identify and retrieve each file in a global namespace that is formed by connecting all computing devices. In short, it is a decentralized way of storing and retrieving data similar to Torrent applications. A hash is generated on adding a file to the IPFS and a user can access the file using the hash. The IPFS then checks through the nodes and provides the client with the file.

MetaMask is an extension for browsers for accessing decentralized applications compatible with ethereum. It lets users create and manage their own identity (via private keys), so when a Dapp wants to perform a transaction, the user can review the transaction securely, before deciding to approve or reject it.

3.4 System Stakeholders and Functions

1) **University:**
University is an entity that does the create, delete, update operation of all other entities in the system. It has the responsibility of being the watchdog of the system and maintaining the registry of all other stakeholders.

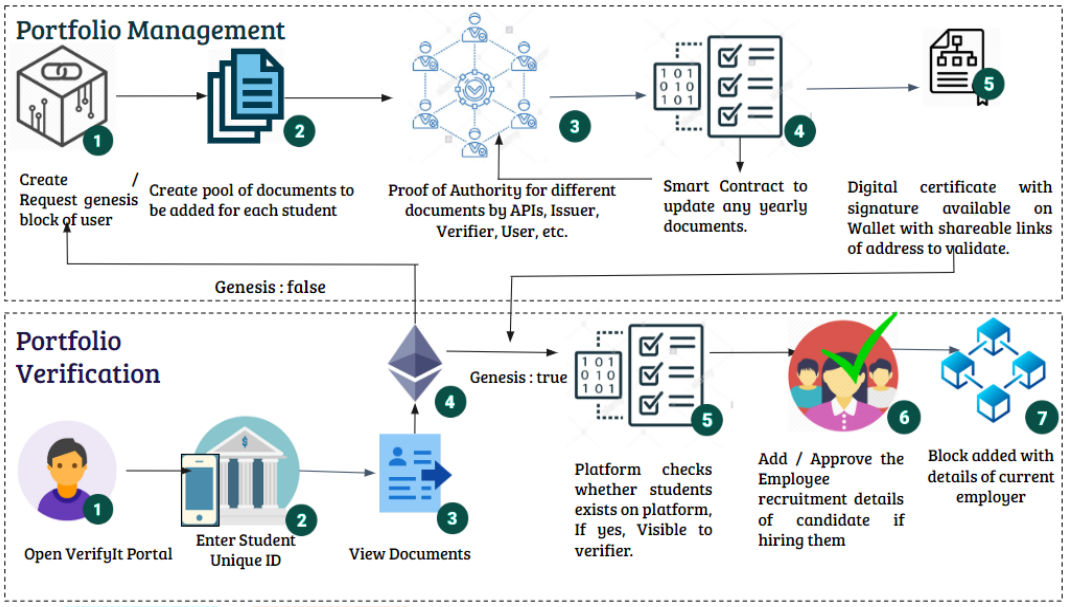

Fig.3. System Workflow Design

2) **Employers:**
Employers are entities who are provisioned to use our platform to access the student's complete portfolio and make recruitment decisions. The platform aids employers in their hiring procedures.

3) **Students:**
Students are entities that are identified by a unique UID in the system and are the key elements of our system. Students need to identify their documents to the external entities and hence, they are assigned with a UID which serves as their public key and the documents can be verified accordingly.

4) **Others:**
There are other stakeholders in our system which include external verifiers which are entities that are not directly related to the university but have an equal voting right to some of the documents of the candidates. These entities may be organizations such as those from where students do some certifications, internships, etc.

3.5 System Operational Design

The system operational design provides a complete system workflow of our proposed system. Figure 3 shows the system's operational architecture for Studentchain.

The design is divided logically into 2 distinct phases:

1) **Portfolio Creation and Management:**
In this phase, a portfolio of students is created based on his unique id and all his documents such as mark sheets, certifications, etc and identity documents such as aadhar card, pan card, etc are also added onto the system for verification.
A genesis block corresponding to every student is initiated on the blockchain. After the documents and information is verified using the PoA(Proof of Authority) Consensus, the data is added to the blockchain and the IPFS for future retrieval. These documents and information are identified by the UID of every student in the system. Documents uploaded yearly like academic mark sheets are also verified and added similarly. Figure 4 shows the student profile after verification by concerned authorities.

2) **Portfolio Verification:**
In this phase, we use PoA(Proof Of Authority) Consensus for determining if the documents presented by the student are authentic and correct. External Verifiers are a part of this phase too. The authentic information is added to the student registry permanently by means of smart contracts to the blockchain and IPFS APIs to the IPFS.

3.6 Smart Contracts

A smart contract allows entities to exchange data in a trusted fashion without having to rely on any third party. They are stored as special transactions on the blockchain, which can then be used to deploy applications.
The smart contracts in our system define a student structure that stores primitive information like the UID, name, and identity information such as AADHAR and PAN numbers.

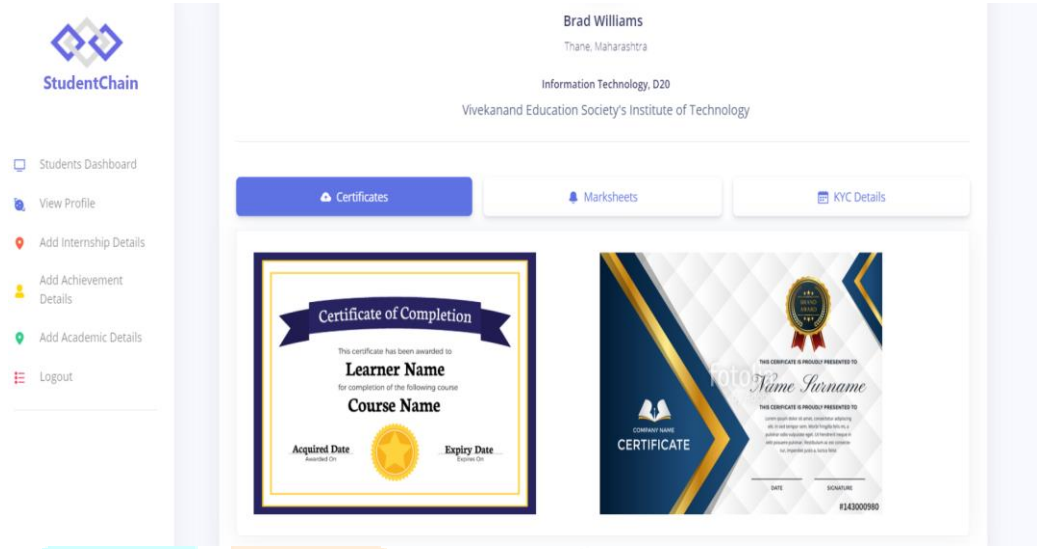

Fig.4. Student profile on StudentChain

Data corresponding to academic scores, internship details, and achievements are also added to the block after verification from authorities. Contract functions are defined for adding these details in the student block and these are invoked when the appropriate authority verifies the documents from the web application. The hashes identifying the location of the document on the IPFS are also added to the respective student blocks. Figure 5 shows the hash of the document uploaded to the IPFS below the file name.

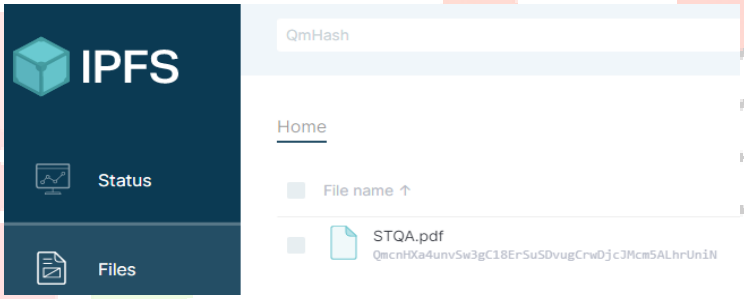

Fig.5. IPFS hash starting with Qm*

3.7 ML Recommendation model

The system integrates together a recommender model for students for suggesting them job profiles based on their skill sets in their resumes, their internships, and all key aspects from their profile.

1) **Extraction Model:**
The rakenltk library is used to extract keywords from the student resume and associate them to various facets of their profile including achievements, experience, and skills.

2) **Recommendation model:**
The keywords extracted from the previous model are fed to the recommendation model to get the job recommendation for the student. This model is a neural network built-in Keras which is an open-source neural-network library running on top of Tensorflow.

3) **Model Training:**
BeautifulSoup is used to scrape keywords associated with different job profiles from all leading job websites which provide a platform for a range of job profiles to the candidates. A dataset is created associating the respective keywords with their job designations. The Keras model is then trained on this dataset to suggest a job profile from the specified

keywords for the candidate. The neural network is trained on the NVIDIA Tesla K80 GPUs provided by Google Colaboratory and saved as an HDF5 file.

Application Programming Interfaces(APIs) are written in order to interface these models with the web application. These APIs are hosted and served using ngrok, which establishes a secure tunnel from a public endpoint such as the internet to a locally running network service, i.e., the API in this case.

4 Results and Conclusions

In all of the world's developing countries, the field of education is a central focus. StudentChain is a concept to digitally receive and share records that are securely verified by the nodes on the blockchain. Moreover, smart contracts will make it easy to filter out students for any benefit disbursal opportunity or potential employer screenings. Figure 6 shows the landing screen of StudentChain with the stakeholder logins and a placeholder for querying the student profile with his UID.

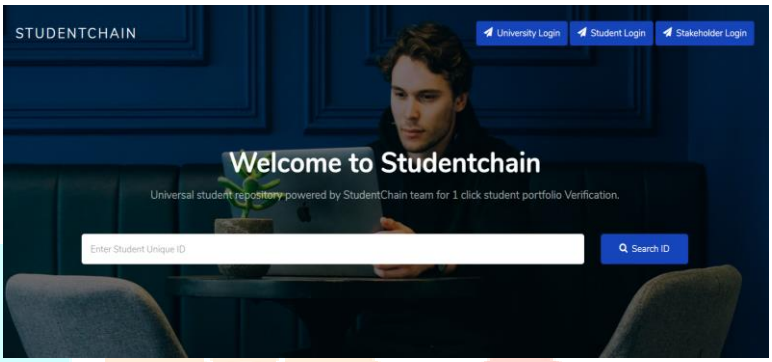

Fig.6. StudentChain Homepage

Paper-based higher education diplomas, school certificates and extra training course certificates get lost and the original can be lost over time. Once on the blockchain, the grade and course information of the students will not get lost, and it is not possible to change or falsify the information as the data on the blockchain is immutable. At the same time, one can easily access this information with the owner's consent. The below figure shows the student profile and his certificates achieved during the academic year.

We wish to make such processes less tedious and painful for the stakeholders. Owing to the immutability of records in blockchain, we expect transparency and mutual trust amongst the stakeholders. This would also reduce the redundancies in the verification system where documents are verified repetitively for various purposes. This also will minimize the time required for processes involving such heavy paperwork. The records uploaded through our portal can be shared with other people with the user's consent.

5 Future work and Scope

Currently, the system has a provision of uploading documents to the IPFS, and these documents are identified using their hashes. Cracking the hashes can make the documents available to an intruder who is unauthorized to access the documents. Asymmetric Encryption techniques can be used to pair with uploading files to the IPFS for enhanced security. The files can be encrypted with the public key of the recipient, so that they can decrypt it using their private keys.

We can apply this concept of StudentChain to a long list of business applications such as direct benefit disbursement of scholarship of the candidate where candidate's documents can be easily verified by their UID over the blockchain system and the long process of paperwork. This also will minimize the time required for processes involving such heavy paperwork. This system is very useful for every organization which will prove them in certain benefits. Apart from this, other use cases that define the scope of the work can be transcript generation of candidates. Today a lot of time is wasted in getting the transcript and verifying it from the universities, use of StudentChain will eliminate the efforts and establish a smooth process there.

6 Acknowledgement

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