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## BLOCKCHAIN-BASED PLATFORM FOR TRACKING STUDENTS' ACHIEVEMENTS

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#### Abstract:

The increasing need for secure, transparent, and verifiable academic credentials has highlighted the limitations of conventional digital certificates, which are often static, hard to validate, and prone to fraud. To address this gap, this paper explores blockchain technology and Non-Fungible Tokens (NFTs) as innovative solutions for academic credentialing. Unlike traditional credentials, NFTs are unique, immutable digital assets stored on a blockchain, enabling decentralized verification and secure ownership.

This study proposes a blockchain-based platform that enables universities to issue NFT (Non-Fungible Token) tokens to students upon completion of coursework, participation in extracurricular activities, and acquisition of specific skills. These tokens are stored on a decentralized ledger and form a tamper-proof record of student achievements accessible to employers, institutions, and other stakeholders.

The paper introduces the "Achievables" business model, which promotes collaboration between universities, students, and employers. A prototype implementation using Ethereum's ERC-721 standard demonstrates the system's core features. Challenges such as scalability, legal frameworks, and institutional adoption are also addressed. The findings suggest that blockchain-based academic credentialing can enhance transparency, student motivation, and employability, offering a secure and learner-centered approach to achievement tracking.

#### Keywords:

Non-Fungible Tokens (NFTs), Higher Education, Digital Credentials, Academic Achievement Tracking, Decentralized Learning.

### INTRODUCTION

Modern higher education is embracing digital transformation to enhance student competitiveness through personalized portfolios and verified records of academic and extracurricular achievements. By leveraging blockchain and NFTs, institutions can issue secure and transparent digital badges that represent milestones, such as course completion, research presentations, or competition awards. These tokens are stored in digital wallets and linked to a decentralized ledger, allowing easy verification by employers, scholarship providers, and other stakeholders. This approach replaces traditional paper certificates with tamper-proof digital credentials, while also providing universities with valuable insights into student engagement, curriculum effectiveness, and long-term outcomes.

## 2. LITERATURE REVIEW

While blockchain's initial applications were concentrated in the financial sector, its potential in education is expanding rapidly, encompassing digital diplomas, e-learning, and decentralized accreditation systems [1]. Universities are increasingly recognizing the efficiency of blockchain-powered solutions, leading to the development of platforms such as EduCTX, which is designed to provide a globally recognized and transparent system for managing academic credits [2].

#### 2.1. BLOCKCHAIN TECHNOLOGIES

Blockchain is a decentralized and immutable digital ledger that records transactions securely across multiple computers. It eliminates intermediaries, enhances security, and ensures transparent data verification. Each transaction is grouped into a block and linked cryptographically, forming a tamper-proof chain of records [3]. Consensus mechanisms, such as Proof of Work (PoW) and Proof of Stake (PoS), govern the validation of transactions. While PoW relies on computational puzzles, PoS selects validators based on token holdings, offering a more energy-efficient alternative. Blockchain has applications in finance, supply chain management, healthcare, and identity verification. It enables decentralized financial transactions, enhances supply chain transparency, and secures patient records. However, challenges such as scalability, regulatory uncertainty, and interoperability between networks remain. [4]. Ongoing advancements, including Layer 2 scaling solutions and hybrid blockchain models, aim to address these issues. With continued development, blockchain is expected to revolutionize digital transactions and data management across various industries. [5].

#### 2.2. NFTS AND NFT MARKETPLACES IN THE CONTEXT OF EDUCATION

Non-Fungible Tokens (NFTs) are unique digital assets stored on a blockchain that verify ownership of digital or physical items. Unlike cryptocurrencies, which are interchangeable, each NFT carries specific metadata that makes it distinct and non-replicable [6]. This makes NFTs particularly suitable for representing academic credentials, as each educational achievement can be encoded with personalized metadata such as course name, grade, instructor, and timestamp. NFT marketplaces, including OpenSea, Rarible, and Foundation, illustrate the technical and economic frameworks for decentralized asset management [7][8]. Although initially intended for creative industries, their structure inspires the development of educational platforms where students can securely store, manage, and share their credentials. By adopting the smart contract mechanisms used in mainstream NFT platforms to automate royalty payments, educational credentials can be issued and tracked securely and efficiently.

Despite their rapid adoption, NFTs face challenges such as price volatility, legal ambiguities, and concerns over environmental impact due to blockchain energy consumption [9]. However, in the context of education, NFTs offer promising advantages in creating transparent, tamper-proof, easily shareable, and verifiable personal records across institutions and platforms.

# 2.3. APPLICATION OF BLOCKCHAIN AND NFT IN HIGHER EDUCATION

The potential of blockchain and NFTs in education is expanding rapidly, introducing new ways to manage academic credentials, digital learning, and institutional governance. Traditional systems for storing academic records rely on centralized databases, which are vulnerable to fraud, data loss, and unauthorized modifications. Blockchain's decentralized nature ensures that academic credentials are securely stored and verifiable by multiple stakeholders, including universities, employers, and government agencies. One of the key applications of blockchain in education is the issuance of digital diplomas and certifications [10]. Platforms such as EduCTX integrate blockchain with the European Credit Transfer and Accumulation System (ECTS), allowing students to store academic credits in a tamper-proof system. This reduces reliance on paper-based documentation and eliminates intermediaries in credential verification [2]. Blockchain-powered Decentralized Autonomous Organizations (DAOs) offer students and faculty members an innovative approach to managing academic policies, learning resources, and institutional governance. Through smart contracts, these systems ensure transparency and inclusivity in decision-making, allowing students to participate in curriculum development and academic management [10].

Smart contracts also automate administrative processes, including degree verification, student enrollment, and the distribution of financial aid. Automated systems reduce operational costs, mitigate fraud risks, and enhance institutional efficiency. Blockchain solutions such as EduRSS enable secure storage and exchange of student achievements, preventing data manipulation and unauthorized access. [11]. NFTs further revolutionize education by offering digital credentialing. Instead of traditional degrees, universities can issue NFT-based digital badges that represent specific skills or competencies acquired through coursework or training programs. These verifiable credentials provide an immutable record of student achievements that can be shared directly with employers and institutions. Beyond credentialing, NFTs facilitate the monetization of educational content. Professors and researchers can tokenize digital textbooks, research papers, and online courses to ensure intellectual property protection. Blockchainbased NFT marketplaces enable the direct distribution of educational materials, eliminating intermediaries and enhancing accessibility and revenue potential for educators. NFT-backed scholarships and funding models present new opportunities for student financial aid. Universities and donors can issue NFT-backed grants, ensuring transparency in fund allocation and supporting students through blockchain-verified sponsorships [12], [13]. Despite these advantages, challenges such as scalability, legal recognition, and environmental concerns remain. Blockchain networks require substantial infrastructure, and the lack of interoperability between platforms remains a significant challenge. Additionally, regulatory frameworks must be developed to standardize NFT-based academic credentials [14].

While prior research and platforms such as EduCTX [2] and EduRSS [11] demonstrate the feasibility of blockchain in academic credentialing, they typically rely on static, institution-driven certificates. These systems lack support for dynamic, skill-specific NFTs and offer limited personalization or student involvement in the credentialing process. This paper addresses that gap by proposing a learner-centered, NFT-based platform that combines academic and extracurricular achievements into a unified, verifiable portfolio. By doing so, it introduces a more modular, transparent, and practical approach to digital credentialing.

## 3. BUSINESS MODEL FOR A BLOCKCHAIN-BASED PLATFORM FOR TRACKING STUDENTS' ACHIEVEMENTS

The "Achievables" business model introduces a blockchain-powered platform that enables universities to issue unique NFT collections as verifiable digital credentials for students' achievements. Rather than focusing solely on GPA or degrees, the platform highlights evolving skill profiles, reflecting students' academic progress and extracurricular activities. Universities create custom NFT badges, which are linked to specific courses, workshops, and formal events. Institutions submit enrollment lists, top-performing students, and graduates, prompting the automatic minting and issuance of NFTs. These tokens serve as secure, decentralized proof of accomplishments. Additionally, students can request personalized NFTs to showcase independent achievements, such as research publications or specialized training. To better conceptualize the proposed platform and its operational structure, the following section utilizes Business Model Canvas. This approach outlines the core elements needed to build, deliver, and capture value in a blockchain-based academic credentialing ecosystem.

- **Business idea:** A platform (named "Achievables") that integrates blockchain technology into education by offering universities unique NFT collections as a form of student recognition for specific academic achievements.
- **Products and services:** Creation of NFT collections for universities, a platform that highlights university NFT collections with a searchable database for hiring companies.
- **Partners:** Universities; Companies looking to hire young talent; Students; Designers
- Key activities: Creating NFT collections for universities; Awarding students NFTs upon reaching specific achievements; Handling unique NFT requests for student profiles; Showcasing NFTs with student profiles on the platform; Collaborating with hiring companies via a searchable skills database; Updating the database annually with universities; Managing student complaints regarding database errors.
- Value propositions: Comprehensive portfolio building for students; Customized learning pathways; Enhanced student engagement; Empowerment of non-traditional learners; Competitive advantage for new graduates; Streamlined talent

acquisition for employers; Global recognition of academic achievements; Data-driven insights for universities; Promotion of blockchain literacy

- Relationship with users: Community building; Intuitive, user-centric design; Effective communication and feedback mechanisms; Personalization; Transparency; Consistent value delivery
- Customer segments: Universities and educational institutions; Students; Employers and hiring teams; Providers of educational services; Regulatory bodies and accreditation agencies; Investors and stakeholders
- Key resources: Financial capital; Human capital; Technological infrastructure; Blockchain technology; Data management systems; Regulatory compliance
- **Channels:** Online platform; Digital marketing; Partnerships with educational institutions
- Cost structure: Technology development and maintenance; Blockchain integration costs; Employee salaries; Marketing and promotion; Legal fees; Office and administration expenses
- **Revenue Streams:** Revenue from partnership and collaboration fees with educational institutions and companies

The "Achievables" business model, as described above, is structured around subscription fees from universities integrating the platform into their academic administration, as well as membership fees from companies accessing the student talent pool. Employers can use advanced search features to identify candidates with specific skills or match them to NFT-verified credentials. Students benefit from enriched academic experiences, improved career prospects, and increased motivation to engage beyond the standard curriculum. The platform also collaborates with digital artists to design institutionbranded NFT graphics. Additionally, small transaction or service fees apply when students request personalized NFTs for extracurricular achievements. This ecosystem fosters close collaboration between universities, employers, and students while actively promoting blockchain literacy in education.

### 4. DEVELOPED A BLOCKCHAIN-BASED PLATFORM FOR TRACKING STUDENTS' ACHIEVEMENTS

Figure 1 displays the prototype homepage of the platform, built with React, highlighting its core features and user interface. The platform is built on Ethereum's ERC-721 standard for NFTs and features a wallet-based login, a user dashboard showcasing earned NFT credentials, and administrative panels for token creation and management. It supports essential operations such as minting new tokens, verifying ownership, and recording transactions through a dedicated smart contract referred to as NFTMarketplace.sol. To ensure compatibility with major digital wallets and marketplaces, such as MetaMask, the platform integrates key contract modules, including ERC721.sol, ERC721Enumerable.sol, IERC721. sol, IERC721Enumerable.sol, and IERC721Metadata.sol. Instead of presenting the Solidity code directly, Listing 1 provides a pseudocode version of the minting logic, abstracting technical implementation details while preserving the functional structure. This approach demonstrates how the platform issues NFT-based academic credentials while promoting good security practices [15].



Figure 1. Platform for Tracking Students' Achievements

```
FUNCTION mintNFT(title, description, metadataURI, salesPrice, paymentAmount):
IF metadataURI already exists:
    REJECT transaction ("This NFT is already minted")
IF paymentAmount < mintingCost:</pre>
    REJECT transaction ("Ether too low in minting")
TE sender TS contractOwner:
    REJECT transaction ("Sales not allowed")
TRANSFER royalty TO artist
TRANSFER remainingAmount TO platformOwner
CREATE transactionRecord WITH metadata:
     - tokenId
     - sender
    - paymentAmount
     - salesPrice
     - title
     - description
     - metadataURT
     - timestamp
EMIT sale event WITH transactionRecord
MINT new NFT with metadataURI to sender
RECORD sender AS NFT owner
MARK metadataURI AS used
```

Listing 1. Mint NFTs function



Figure 2. IT Student and Management Student

This function ensures that only valid, unique tokens are issued. It performs key validation checks, calculates and distributes royalties, creates an on-chain transaction record, and safely mints the token to the student's wallet. Each NFT includes descriptive metadata such as the student's name, the course or achievement represented, the issuing institution, and the time of issuance. By abstracting these operations into a smart contract, the system maintains transparency, traceability, and automation in the credentialing process. The system's decentralized design reduces administrative workload while enabling students to control and share their credentials independently. When a student first enrolls in a university that is part of the system, they receive an enrollment NFT that attests to their official registration on the platform.

Figure 2 presents sample NFT tokens issued to students upon enrollment in their respective study programs. These enrollment NFTs serve as the initial credentials in a student's blockchain-based academic record. Each token includes metadata that identifies the study track (e.g., IT or Management), the enrollment year, and the issuing institution. This mechanism replaces traditional registration confirmations with verifiable, tamper-proof credentials anchored on the blockchain. By integrating institutional branding and metadata, these NFTs ensure authenticity while laying the foundation for subsequent academic achievements within the platform.

As students progress through their studies, they may receive additional NFTs upon completion of specific courses or projects. Each token contains metadata such as course name, learning objectives, instructor identity, and grade, thereby forming a dynamic and detailed academic portfolio over time. Beyond academic milestones, the platform also supports the issuance of NFTs for extracurricular accomplishments. These may include participation in hackathons, boot camps, or independent research, with tokens encoding verified information about the acquired skills and the context in which they were gained. This functionality enables institutions to validate and reward a broader range of student development, encompassing both formal and informal learning outcomes.

## 5. CONCLUSION

By integrating blockchain and NFT technologies with conventional models of higher education, this platform conceptually illustrates a next-generation credentialing system that addresses several chronic pain points in academic and professional settings. The decentralized blockchain enables tamper-proof record-keeping, thus reducing the administrative burden of verifying records and minimizing credential fraud. NFTs enable granularity to represent each student's unique accomplishments, offering employers more insight into individual competencies. While eventual roadblocks include transaction costs on clogged networks, differing institutional policies, and the need for standardized data formatting, the current development of blockchain infrastructure and the broader adoption of digital assets suggest that such barriers can be gradually eroded. Additionally, such a system could enhance student motivation, as they earn tokens for diverse skill sets that are reflected in their final transcripts. Universities, in return, get a secure data platform that bolsters their reputation for innovation while providing them with real-time snapshots of student achievement. As higher education increasingly embraces digital transformation, blockchain-based achievement-tracking platforms are going to be at the heart of how credentials get stored, shared, and verified.

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272



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