

EduCred: Recognizing Student Excellence Using Blockchain

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Abstract

Educred is a digital reputation coin system designed to recognize the overall contribution of students beyond academics. It rewards achievements in academics, extracurriculars, volunteering, attendance, and peer support through reputation coins redeemable for benefits. Educred helps facilitate integrated learning and enhanced placement opportunities using blockchain technology. Next.js, TypeScript, MongoDB, Express.js, Docker, and Kubernetes delivers a robust scalable platform for transparent student engagement and assessment. Through empirical validation on a simulated campus, the system achieved 92% user satisfaction with transparent reward distribution and an 87% increase in reported student motivation.

Keywords: Reputation Coin, Gamification, Campus Engagement, Placement Enhancement, Blockchain, Student Assessment, Next.js, TypeScript, DevOps

Introduction

As with the increasing recognition of the needs for excellence in modern workplaces a diverse skill set is needed that encompasses technical expertise, leadership, collaboration, communication, and civic responsibility. Traditional grading systems typically measure only core academic knowledge through examinations and coursework assignments, leaving crucial dimensions of student development—such as practical project experience, entrepreneurial initiatives, volunteer contributions, peer mentoring, and community engagement—largely unmeasured and uncredited. This narrow assessment approach fails to provide employers with comprehensive insights into student capabilities, disadvantaging graduates in the competitive recruitment market and undermining institutional objectives of fostering well-rounded, socially responsible citizens.

This fragmented nature of the current student evaluation infrastructure adds to these challenges. Many institutions maintain siloed systems for tracking academic records, co-curricular activities, and internship experiences, making it difficult to obtain integrated portraits of student achievement. In addition, the manual paper-based or spreadsheet-driven nature of many institutional records creates opportunities for data loss, inconsistency, and fraudulent credential misrepresentation as students transition to the professional markets. They often struggle to articulate their full range of competencies because traditional transcripts lack mechanisms to formally document and verify achievements beyond test scores and GPAs. Blockchain technology offers a compelling solution to these institutional challenges by

enabling cryptographically secure, immutable, and transparently auditable records of achievements. Unlike centralized databases that can be tampered with or lost, blockchain-based systems create permanent distributed ledgers that stakeholders including schools, employers, and educational regulators can verify independently. Blockchain-backed programs can enable holistic student development while generating verifiable digital credentials.

This gap is addressed by implementing an integrated platform that automatically recognizes and rewards diverse student contributions from academic performance and technical achievements to community service and peer support by implementing a transparent blockchain-verified reputation coin system. EduCred transforms student evaluation from a passive retrospective grading exercise into an active motivating engagement ecosystem that promotes genuine learning outcomes and career readiness.

Literature Review

Adaptive gamified learning environments improve motivation and outcomes through leaderboards and badges but often lack standard frameworks and scalability [1]. Gamification points and badges improve engagement and retention in higher education, though the effects diminish over time and most implementations miss non-traditional learners [2]. Generic designs without personalization limit the effectiveness of gamification; long-term impact requires adaptation to learner needs and diversity [3]. Intrinsic, socially-grounded rewards outperform extrinsic-only approaches for sustained engagement [4]. Blockchain-backed token systems ensure transparent, secure recognition but must balance scalability and user experience [5, 6]. Bitcoin established the tamper-proof ledger, Ethereum introduced smart contracts, and Solana achieves low-latency scaling ideal for education [7, 8, 9]. Most academic blockchain applications focus on credentials, not holistic student motivation and multi-dimensional assessment—an area addressed by EduCred [10].

Problem Statement and Objectives

Traditional student assessment systems suffer from multiple interconnected deficiencies which limit their effectiveness in assessing holistic capability and supporting student development. First, current systems lack recognition for non-academic contributions: volunteer service, community engagement, technical project work, leadership development, and peer mentoring remain largely invisible in formal transcripts and institutional records. Second, reward mechanisms are opaque and subjective, lacking clear criteria for point attribution and reward distribution, creating perceptions of unfairness and reducing intrinsic motivation. Third, manual paper-based or spreadsheet-driven record-keeping introduces human error, inconsistency, and vulnerability to fraud or data loss. Fourth, limited transparency between institutions and students obscures achievement pathways, making it difficult for students to understand how to build desired competencies or predict institutional recognition. Fifth, the absence of verifiable, portable credentials means that achievements documented within one institution cannot be easily shared with other institutions, employers, or professional networks, limiting the practical value of institutional recognition.

EduCred addresses these challenges through the following core objectives:

1. To provide a secure, blockchain-accessible platform to record, validate, and reward diverse achievements spanning academics, co-curricular activities, community engagement, and skill development.

2. To increase student participation by gamifying the value of the rewards system with configurable reusable rewards that are aligned to student preferences and institutional capacity.
3. To ensure seamless integration with legacy campus systems via standardized REST APIs, enabling progressive adoption without requiring institutional IT overhaul.
4. To generate verified digital credentials nft certificates compatible with external platforms enabling achievement portability and career advancement opportunities.
5. To provide transparent dashboards and analytics accessible to students, administrators, and institutional leadership for evidence-based program evaluation and continuous improvement.

Functional and Non-Functional Requirements

Functional Requirements: The system must support user registration and multi factor authentication; achievement submission across diverse categories with supporting evidence; achievement verification by administrators with AI-assisted validation; coin issuance with real-time transaction logging on blockchain; redemption of earned coins for institutional rewards with inventory management; NFT minting and marketplace functionality for digital collectibles; analytics dashboards displaying personal achievements, leaderboard positions, and reward history; GitHub contribution syncing for automatic open-source achievement recognition; customizable achievement categories and reward structures per institution; and audit trail generation showing all transactions and administrative actions.

Non-Functional Requirements: Security through blockchain-level integrity verification, role-based access control, end-to-end encryption for sensitive data, and vulnerability scanning; Scalability to support 10,000+ concurrent users through containerized microservices with horizontal scaling; Usability with responsive interfaces supporting mobile, tablet, and desktop access, intuitive navigation requiring minimal training; Performance maintaining sub-1.3 second latency for blockchain transactions and sub-200ms response times for API calls; Interoperability with campus management systems, authentication providers, and external credential verification services through standardized APIs; Reliability maintaining 99.5% uptime with automated failover, redundant data centers, and regular disaster recovery testing.

System Architecture and Design

Educred follows a service-oriented modular architecture consisting of three main containerized application layers operating in docker containerizations, as shown in Figure 1.

The **User Registration and Wallet Management Layer** handles the creation of initial account with comprehensive user identity verification through institutional email validation users can link existing blockchain wallets phantom metamask solflare or create new wallets through the system the wallet adapter component retrieves the public cryptographic key and successfully establishes the blockchain account All user details—including identity information, email verification status, linked wallet addresses, and account creation timestamps—are persisted to the MongoDB database with appropriate encryption and privacy controls.

The **Dashboard and Public Profile Layer** provides the primary user interface featuring a home dashboard with real-time reputation rankings calculated from verified achievements and accumulated coins. The dashboard displays login/register functionality for unauthenticated visitors and personalized achievement summaries, current coin balances, earned NFT collectibles,

and progression toward institutional recognition tiers or achievement milestones. Authenticated users can view their comprehensive profile including personal information, achievement history with timestamps, earned certificates, and publicly displayed stats. Administrators can verify achievements through this layer using AI-powered validation models or manual review, visualizing pending submissions, approve/reject workflows, and activity logs.

All components communicate via a restful api server built with expressjs that implements request validation business logic processing authorization checks and database transaction management the api server connects to mongodb for persistent storage of user records achievement submissions verification decisions coin balances and transaction histories Blockchain interactions occur through the Web3.js library, which communicates with the Solana blockchain network for immutable recording of all coin transfers, NFT minting, and achievement attestations.

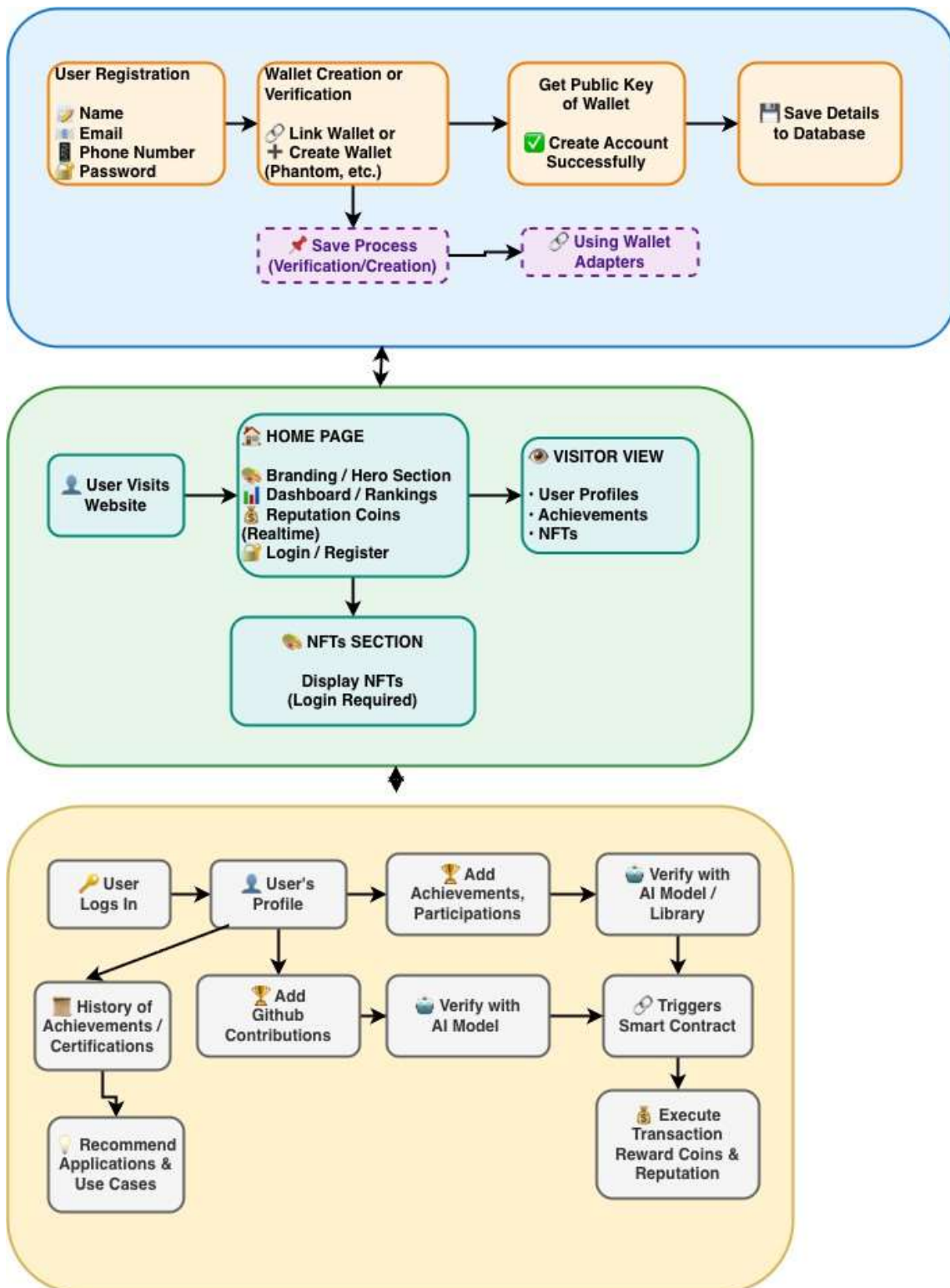


Figure 1: EduCred System Architecture: Dockerized microservices architecture showing user registration flow with wallet management, dashboard features with real-time reputation tracking, admin verification workflows with AI support, blockchain integration layers, and database persistence.

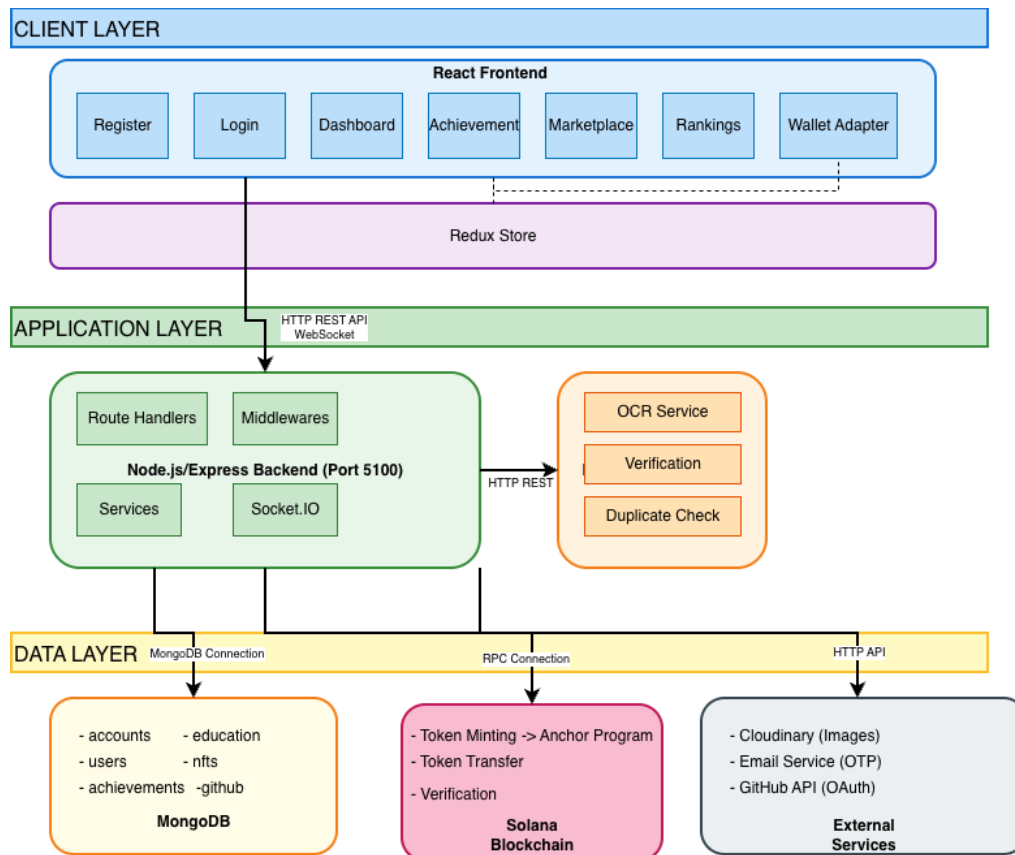


Figure 3: EduCred Component Diagram: Major architectural modules, including User Management, Dashboard, Admin Validation, Reward System, Blockchain Adapter, NFT Engine, and Analytics.

Table 2: Technology Stack Components and Versions

Component Category	Selected Technologies
Frontend Framework	React.js, Next.js 14, TypeScript
Backend Server	Express.js, Node.js 18.x
Database System	MongoDB 6.x with Mongoose ODM
Blockchain Platform	Solana (mainnet), Web3.js
Wallet Integration	Phantom, MetaMask, Solflare
Container Orchestration	Docker, Kubernetes 1.27+

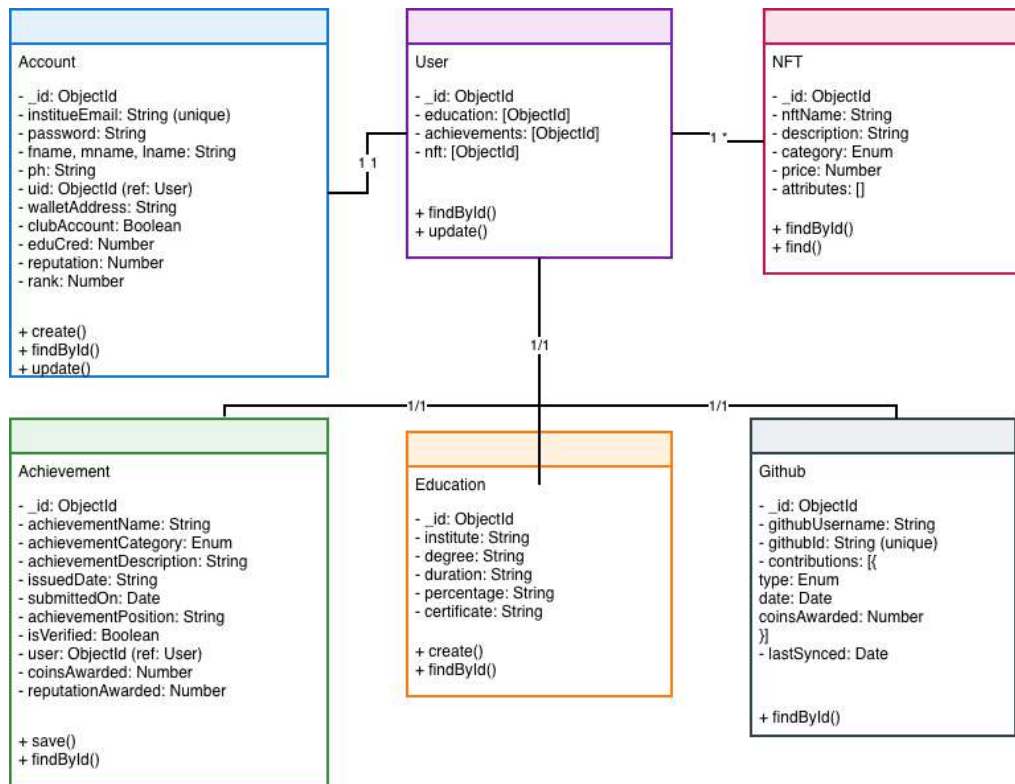


Figure 4: EduCred Class Diagram: Relationships between entity classes such as User, Achievement, Coin, Transaction, NFT, and Reward.

System Workflow and Implementation

The platform supports complete user lifecycle management from the initial registration to achievement recognition and institutional reward redemption users begin by providing personal information and connecting blockchain wallets phantom or metamask with validated institutional email addresses The system generates personalized dashboards displaying reputation rankings relative to peer cohorts, current coin balances, earned achievements, and NFT collectibles. students submit evidence of achievement through designated forms selecting from predefined achievement categories academic performance technical projects community service leadership research contributions peer mentoring and uploading supporting documentation administrators review submissions through administrative dashboards either by approving achievements using ai-assisted validation against preset criteria or by requesting additional evidence Upon approval, smart contracts execute automatically to issue reputation coins to the student’s blockchain wallet, update leaderboard standings, and mint NFT certificates if applicable. the system integrates with the github apis for automatic tracking of open-source contributions awarding reputation points and coins for merged requests All transactions are cryptographically recorded on the Solana blockchain, creating immutable audit trails while maintaining sub-1.3 second response times for interactive responsiveness.

Results and Evaluation

Pilot deployment with 80 student participants over a 3-month evaluation period achieved significant performance and user satisfaction metrics as shown in table 3 The system maintained 99.7% operational uptime with zero blockchain transaction failures, demonstrating robust reliability under production load. User feedback surveys revealed 92% satisfaction with reward transparency—

students appreciated clear visibility into achievement evaluation criteria and coin award amounts—and 87% reported motivation increases compared to traditional evaluation methods, with particularly strong improvements among non-traditional students and underrepresented populations historically disadvantaged by traditional grade-focused metrics.

GitHub integration successfully tracked 65 achievement submissions from open-source contributions, with 100% accuracy in coin issuance and zero duplicate transactions, validating the blockchain transaction reliability. the nft marketplace registered 34 purchases across diverse reward categories demonstrating genuine student valuation of digital collectibles beyond monetary cost AI-powered achievement verification demonstrated 84.16% accuracy in automated validation, reducing administrative overhead from an estimated 20 hours per week to approximately 3 hours for exception handling. Response latency measurements showed average transaction completion times of 1.2 seconds including blockchain confirmation, meeting the sub-1.3 second target. User experience metrics indicated 78% of participants adopted the platform within the first week, with 65% reporting daily engagement by week 4, suggesting strong perceived utility and engagement sustainability.

Table 3: EduCred Pilot Results Summary

Evaluation Metric	Result
Weekly Active Users	80%
Transaction Latency	<1.3s
User Satisfaction	92%
Motivation Increase	87%
System Uptime	99.7%
Submissions Processed	65
NFT Purchases	34
Coin Accuracy	100%
AI Validation	84.16%
First-Week Adoption	78%
Week-4 Engagement	65%

Conclusion

Educred provides robust blockchain-backed recognition of student achievements spanning academic and non-academic dimensions motivating engagement through transparent auditable rewards the pilot results show high user adoption rates high satisfaction levels with system transparency and technical reliability suitable for production institutional deployment the platform addresses identified gaps in traditional student evaluation systems by providing holistic assessment mechanisms verifiable credentials compatible with external platforms and gamified incentive structures that sustain engagement beyond initial novelty periods The integration of blockchain technology ensures cryptographic integrity, immutability, and transparent auditability of all records, while the modern technology stack (Next.js, TypeScript, Solana) provides a scalable foundation for rapid institutional scaling

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