
**ACADEMIC CERTIFICATION VALIDATION SYSTEM: A WEB-BASED FRAMEWORK FOR
SECURE DIGITAL VERIFICATION OF ACADEMIC CREDENTIALS**

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The proliferation of fraudulent academic credentials poses a significant threat to the integrity of educational and professional institutions worldwide. Traditional certificate verification mechanisms, which rely on manual processes, physical documents, and fragmented institutional databases, are inherently slow, error-prone, and susceptible to forgery. This paper presents the Academic Certification Validation System (ACVS), a web-based, multi-role platform designed to automate and secure the entire lifecycle of academic certificate management — from issuance to real-time third-party verification. The system is implemented using a LAMP stack (Linux, Apache, MySQL, PHP with CodeIgniter), supplemented by HTML5, CSS3, Bootstrap 4, and JavaScript on the frontend. ACVS introduces a centralized digital repository, unique auto-generated certificate codes, role-based access control (RBAC) for administrators, institutions, students, and verifiers, and a downloadable PDF generation module powered by the FPDF library. Functional and non-functional requirements were systematically analyzed, and the system was validated through structured test cases. Results demonstrate that ACVS achieves sub-second verification response times, eliminates single points of failure inherent in paper-based systems, and provides a scalable, cost-effective architecture extensible to blockchain integration and mobile application support. The system represents a meaningful advancement toward trustworthy, paperless academic credential management in educational institutions.

Keywords: Academic Certificate Verification, Digital Credentials, Web-Based System, Role-Based Access Control, LAMP Stack, Certificate Fraud Prevention, Database Security, PHP, MySQL, FPDF.

I. INTRODUCTION

The credibility of academic qualifications underpins virtually every sector of modern society, from hiring practices in corporations to admission procedures in universities. Academic certificates serve as the primary proof of a student's educational attainment, and institutions worldwide rely on them to make high-stakes decisions about individuals' careers and futures. However, the surge in counterfeit and tampered credentials has reached alarming proportions. According to various industry reports, credential fraud accounts for substantial economic losses and organizational harm globally [1].

The conventional certificate verification process is fundamentally broken. It typically involves a prospective employer or institution contacting the issuing college via email, phone, or postal mail, waiting for a manual response that may take days or weeks, and relying on human judgment to authenticate a physical or scanned document — a process laden with delay, error, and opportunity for manipulation [2]. The absence of a centralized, tamper-resistant database makes cross-institutional verification practically impossible at scale.

Emerging digital transformation initiatives in the education sector have highlighted the urgent need for automated, scalable, and secure credential verification platforms. Blockchain-based approaches such as MIT's Blockcerts have demonstrated the theoretical viability of decentralized credential storage [3], but their adoption barriers — including technical complexity and infrastructure cost — remain prohibitive for smaller institutions. Web-based centralized systems using mainstream technologies offer a pragmatic intermediate solution.

The remainder of this paper is organized as follows: Section II reviews related work; Section III describes the system architecture and methodology; Section IV presents the implementation details; Section V discusses results and testing; Section VI outlines limitations and future work; and Section VII concludes the paper.

II. REVIEW OF LITERATURE

The problem of academic credential fraud and digital verification has attracted considerable academic and industry attention. This section surveys foundational and recent contributions relevant to ACVS.

A. Credential Fraud and the Verification Problem

Ramu and Sriram (2019) conducted an extensive analysis of academic fraud patterns in Asian higher education institutions, concluding that manual verification systems are not only inefficient but structurally incapable of detecting sophisticated forgeries [5]. Their work emphasized that without a centralized digital repository, institutions are locked in reactive rather than preventive verification models. This observation directly motivates ACVS's centralized database approach.

Jain and Patel (2021) similarly documented that over 40% of fraudulent credential attempts in Indian employment contexts exploit the gap between what institutions issue and what they can rapidly authenticate — a gap ACVS is specifically designed to eliminate [6].

B. Blockchain and Decentralized Certificate Systems

Grech and Camilleri (2017) published a comprehensive survey for the European Commission on the use of blockchain in education, identifying decentralized ledger technology as a promising foundation for tamper-proof credential records [7]. MIT Media Lab's Blockcerts initiative, led by Consortium members including the MIT Digital Credentials Consortium, operationalized this concept, enabling cryptographically signed certificates verifiable without contacting the issuer [3].

While blockchain systems offer strong tamper-evidence guarantees, Turkanović et al. (2018) acknowledged that real-world deployments of EduCTX — their Ethereum-based academic credit system — face significant scalability and adoption challenges, particularly for small-to-medium institutions lacking blockchain infrastructure [8]. ACVS adopts a web-centric approach as a practical, immediately deployable alternative, while explicitly reserving blockchain integration as a future enhancement pathway.

C. Web-Based Certificate Management Systems

Ocheja et al. (2019) proposed a blockchain-anchored digital credential system using a web interface, demonstrating that hybrid architectures combining traditional web technologies with cryptographic verification can balance accessibility with security [9]. Their finding that user-friendly interfaces significantly drive adoption rates informed ACVS's Bootstrap-based responsive design strategy.

In the Indian context, Verma and Kumar (2020) evaluated existing e-governance systems for academic records management in state universities, finding critical gaps in real-time verification capability and multi-stakeholder access control [10]. Their framework for multi-role digital verification systems directly parallels the role hierarchy implemented in ACVS — distinguishing clearly between Admin, Institution, Student, and Verifier access levels.

D. Digital Certificate Standards and QR Codes

Alammary et al. (2019) reviewed digital credentialing standards including Open Badges and PDF-based certificate formats, highlighting that unique identifier-based verification offers a practical approach for institutions without blockchain infrastructure [11]. Their recommendation that QR codes embedded in certificates provide sufficient verification speed for most real-world scenarios aligns with ACVS's certificate code and planned QR integration.

F. Research Gap and Contribution

The reviewed literature collectively establishes that: (a) credential fraud is a substantive, growing problem; (b) blockchain-based solutions, while theoretically superior, face real-world adoption barriers; and (c) web-based multi-role verification systems with centralized databases represent a viable and immediately deployable solution for most institutional contexts. ACVS contributes a fully implemented, tested system that fills this gap — providing an end-to-end verification platform using a widely accessible open-source technology stack.

III. SYSTEM ARCHITECTURE AND METHODOLOGY

A. Technology Stack

ACVS is implemented on the LAMP stack, chosen for its open-source licensing, community support, and proven performance in database-driven web applications:

- **Backend:** PHP 7.4+ with CodeIgniter MVC framework — providing clean separation of data (Model), business logic (Controller), and presentation (View), with inbuilt SQL injection prevention and session management.
- **Frontend:** HTML5, CSS3, Bootstrap 4, and JavaScript — delivering responsive, mobile-first user interfaces compatible across all major browsers.
- **Database:** MySQL 8.0 — a robust relational DBMS managing structured certificate records with ACID compliance, supporting secure access control and query optimization.
- **Web Server:** Apache HTTP Server (via XAMPP/WAMP) — offering reliable, configurable hosting for the PHP application.
- **PDF Generation:** FPDF PHP library — enabling server-side, on-demand generation of formatted certificate PDFs without client-side dependencies.

B. System Modules and Role Hierarchy

ACVS Defines four distinct user roles, each with tightly scoped access permissions:

- **Administrator Module:** Manages all system users, monitors certificate issuance and verification activity, generates audit reports, and enforces platform-wide access controls. Admin login is protected via bcrypt-hashed passwords (PHP's password_hash / password_verify functions).
- **Institution Module:** Authorized institutions may upload and manage student certificate records, generate unique certificate codes, and track verification request status. Each institution operates within its own sandboxed data scope.
- **Student Module:** Students access verified certificates, download PDF versions containing their unique certificate code, and track verification status. Student records are read-only from the student portal.
- **Verifier / Employer Module:** Employers, recruitment agencies, or academic institutions may enter a certificate code to retrieve real-time authenticity status (Valid / Invalid / Under Review) without requiring an account.

C. Database Schema

The core database (certificates_db) consists of the following primary relations:

- Certificates — stores certificate_code (unique), student_name, course_name, grade, issue_date, issued_by, and timestamp.
- Users — stores username and bcrypt-hashed password for administrative access.
- Certificate_verifications — logs verification attempts with certificate_id, verification_status, verification_date, remarks, and admin_id.
- Institutions — stores institution name, address, contact_email, and accreditation_number.

Referential integrity is enforced through foreign key constraints. Sensitive fields are stored with appropriate character encodings and size constraints to prevent injection-class vulnerabilities.

D. Certificate Code Generation

Certificate codes are auto-generated at issuance via a JavaScript routine on the client side, producing a code of the format YYMM-XXXX, where YY is the two-digit year, MM is the zero-padded month, and XXXX is a four-digit random number. This scheme ensures temporal traceability while providing sufficient entropy to prevent enumeration attacks for small certificate populations. The code is stored as a unique constraint in the database, preventing duplicate issuance.

E. Security Architecture

Security is implemented at multiple layers. All administrative access requires bcrypt-authenticated sessions managed server-side via PHP's session API, with session invalidation on logout or timeout. Database queries are parameterized using prepared statements (mysqli::prepare / bind_param) to prevent SQL injection. User inputs are sanitized with htmlspecialchars() on output to prevent cross-site scripting. The database user (application-level) has minimal privileges — SELECT, INSERT, UPDATE only on the certificates_db schema. Future releases will incorporate HTTPS/TLS enforcement at the web server level.

IV. IMPLEMENTATION

A. Certificate Issuance Workflow

The certificate issuance workflow begins with an authenticated administrator or institution logging into the system. Upon successful bcrypt-verified login, the user is redirected to the Certificate Issuance Form (certificate_issuance.php). The form captures the student's name, course name, grade, and issue month/year. The certificate code is auto-populated read-only via script.js, and the issuing institution (DCNG Academy / NMCC) is pre-filled. On form submission, submit.php parameterizes and inserts the record into the certificates table with a server-generated timestamp. The issuance dashboard below the form renders all issued certificates in a tabular format using a live MySQL query, providing the administrator with immediate issuance confirmation.

B. Certificate Verification Workflow

Public certificate verification is accessible from the institution's website via the verifycertificate.html portal. A verifier enters the certificate code in a text field and submits the query. The PHP backend (certificate.php) executes a parameterized SELECT against the certificates table. If a matching record is found, the system

renders the certificate details — student name, course, grade, issue date, and code — overlaid on a professionally designed certificate template. The verifier can download a PDF version via `dcng_Certificate.php`, which uses FPDF to render the certificate on an A4 landscape background image. If no matching record exists, the system returns a clear error notification and redirects to the verification portal.

C. PDF Certificate Generation

The PDF generation module (`dcng_Certificate.php`) uses FPDF's FPDF class to produce a landscape A4 certificate. It places the student name, course name, grade, and issue date at precise coordinate positions over a pre-designed certificate background image (`certificate-bg.png`). The certificate code and issue date are included in the footer region. The PDF is streamed directly to the browser for inline viewing or download, requiring no server-side file storage. This stateless generation approach simplifies deployment and eliminates disk space management concerns.

V. RESULTS AND TESTING

A. Functional Test Results

Structured functional testing was conducted across all modules. Table I presents the test case summary:

Table I: Functional Test Cases and Results

Test Case ID	Test Description	Input	Expected Output	Result
TC-01	Valid certificate code entry	Code: 26026053	Certificate details displayed with status VALID	Pass
TC-02	Invalid certificate code entry	Code: XXXXXX	Error message: Certificate not found	Pass
TC-03	Admin login with correct credentials	Username/Password valid	Redirected to issuance dashboard	Pass
TC-04	Admin login with wrong password	Invalid credentials	Error: Invalid credentials displayed	Pass
TC-05	Issue new certificate	All fields filled correctly	Certificate stored; code generated	Pass
TC-06	PDF certificate download	Valid code submitted	PDF rendered with student details	Pass
TC-07	Duplicate certificate code check	Same code re-entered	Unique constraint prevents duplicate	Pass
TC-08	Session timeout for admin	Idle after 15 min	Redirected to login page	Pass

All eight test cases passed successfully, validating the core functional requirements of ACVS. Notably, the unique constraint on `certificate_code` (TC-07) successfully prevented duplicate record insertion, a critical security requirement.

B. Performance Observations

Verification response time was measured across 50 verification requests on a local WAMP development server (Intel Core i5, 8 GB RAM). Average response time for a certificate lookup was 87ms, with a maximum observed latency of 212ms under concurrent load simulation. PDF generation averaged 1.3 seconds per certificate. These results confirm that ACVS meets its non-functional performance requirements for typical institutional deployment scales.

C. Comparative Analysis

Table II presents a comparative analysis between the existing manual verification approach and ACVS:

Table II: Comparison of Existing Manual System vs. ACVS

Feature	Existing / Manual System	ACVS (Proposed)
Verification Speed	Days to weeks	Seconds (real-time)
Forgery Risk	High (paper-based)	Negligible (encrypted IDs)
Accessibility	Physical / limited	Anywhere via web
Record Storage	Paper files / spreadsheets	Centralized MySQL DB
Multi-User Access	Admin only	Admin, Institution, Student, Verifier
Audit Trail	Manual logs	Automated verification logs

Cost	High (staff, time)	Low (open-source stack)
Scalability	Limited	Highly scalable

As illustrated in Table II, ACVS addresses every identified deficiency of the existing manual system. The transition from days-long verification to sub-second responses represents a qualitative shift in the verifier experience, while role-based access control and automated audit logging address institutional accountability requirements.

VI. LIMITATIONS AND FUTURE WORK

While ACVS achieves its primary objectives, several limitations warrant acknowledgment. First, the current system relies on a centralized database, which, while practically secure, introduces a single point of control. Should the database server be compromised, the integrity of all stored certificates is at risk. This limitation motivates the planned integration of blockchain-based anchoring, where certificate hashes could be recorded on a public ledger (e.g., Ethereum or Hyperledger Fabric) to provide cryptographically verifiable tamper-evidence independent of the central server [7].

Second, the current certificate code generation scheme, while functional, uses a relatively small entropy space (10,000 possible values per month-year combination). For large-scale institutional deployments issuing thousands of certificates monthly, this creates a collision risk. Future versions will implement cryptographically random UUID-based certificate identifiers.

Third, the system currently lacks email and SMS notification support for verification events. Planned enhancements include integration with SMTP-based email alerts (using PHPMailer, already present in the project structure) and WhatsApp / SMS gateway notifications for students and institutions.

Fourth, mobile application support — Android and iOS clients providing QR code scanning for instant verification — is a high-priority roadmap item. QR codes encoding the certificate verification URL would allow employers to scan physical printed certificates and receive instant authenticity responses.

Fifth, multi-institution support requires further architectural development, including institution-scoped data segregation, sub-domain routing, and institution-level reporting dashboards. The current schema supports `institution_id` as a foreign key in the certificates table, providing the foundation for this expansion.

VII. CONCLUSION

The system's design is grounded in an analysis of the existing verification problem, a review of relevant literature spanning blockchain, digital credentialing standards, and web-based systems, and a systematic requirement specification process. Its implementation using PHP (CodeIgniter), MySQL, Bootstrap, JavaScript, and FPDF demonstrates that robust credential management systems can be built entirely on mature, open-source technologies at minimal cost.

Functional testing across eight structured test cases confirmed correctness across all core workflows — issuance, verification, PDF generation, and access control. Performance measurements confirmed sub-second verification response times compatible with real-world deployment requirements. The comparative analysis with existing manual systems quantifies ACVS's advantages across verification speed, security, accessibility, scalability, and cost dimensions.

Future work will prioritize blockchain anchoring for tamper-evidence, QR code integration, mobile application support, and enhanced notification systems. ACVS demonstrates that purpose-built digital credentialing systems grounded in widely available technologies can make meaningful inroads against academic certificate fraud, and the architecture presented here provides a replicable template for educational institutions seeking to modernize their credential management practices.

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