

Student Management Course Registration System with QR Certificate Verification

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Abstract: The increasing demand for digital solutions in educational institutions has led to the development of efficient student management systems. This paper presents a Student Management Course Registration System with QR Certificate Verification, a web-based application designed to automate student registration, course enrolment, certificate generation, and verification processes. The system is developed using Java, JSP, Servlets, Hibernate ORM, MySQL, HTML, CSS, JavaScript, and Apache Tomcat. It provides separate modules for students and administrators, enabling secure login, course management, online registration, and certificate generation. Each certificate contains a unique QR code that allows instant verification of its authenticity, reducing the risk of certificate forgery. The system also integrates email notifications to inform students about successful registrations and certificate availability. Hibernate ORM simplifies database management and improves data consistency, while session management ensures secure access to the application. The proposed system reduces manual effort, improves administrative efficiency, enhances certificate security, and provides a reliable and user-friendly solution for modern educational institutions.

Keywords: Student Management System, Course Registration, QR Code Verification, Hibernate ORM, Java, MySQL, Certificate Authentication, Web Application.

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I. INTRODUCTION

Educational institutions are increasingly adopting digital technologies to improve the efficiency of academic and administrative activities. Traditional methods of managing student records, course registrations, and certificate verification are often time-consuming, paper-based, and prone to human errors. These limitations create challenges in maintaining accurate records, providing timely services, and ensuring the authenticity of academic certificates. Therefore, there is a growing need for a secure and automated system that can effectively manage these processes.

The Student Management Course Registration System with QR Certificate Verification is a web-based application designed to simplify student management and course registration while enhancing certificate security.

The system enables students to register, log in, view available courses, enrol online, and access their course information. Administrators can efficiently manage student records, courses, registrations, and certificate generation through a centralized interface. The application is developed using Java, JSP, Servlets, Hibernate ORM,

MySQL, HTML, CSS, JavaScript, and Apache Tomcat, ensuring a reliable and scalable platform. One of the major features of the proposed system is QR code-based certificate verification. A unique QR code is generated for each certificate and linked to the corresponding student record in the database. By scanning the QR code, employers, educational institutions, or other stakeholders can instantly verify the authenticity of the certificate, thereby reducing the risk of certificate forgery. In addition, the system integrates automated email notifications to inform students about successful course registrations and certificate availability.

The proposed system reduces manual effort, improves data accuracy, enhances administrative efficiency, and provides secure certificate verification. By integrating student management, course registration, QR code authentication, and email notification into a single platform, the system offers a practical and reliable solution for modern educational institutions.

II. LITERATURE SURVEY

Several researchers have developed web-based student management and course registration systems to improve

academic administration and reduce manual work. Existing systems mainly focus on maintaining student records, course enrolment, attendance, and examination management. Although these systems improve operational efficiency, many lack advanced features such as secure certificate verification and automated communication.

Recent studies have introduced QR code technology for certificate authentication to prevent certificate forgery and simplify the verification process. QR code-based verification enables employers and educational institutions to validate certificates instantly by accessing information stored in a centralized database.

However, many of these solutions are implemented as standalone verification systems and are not integrated with student management or course registration modules. Several web applications have also adopted Hibernate ORM for efficient database management. Hibernate simplifies object-relational mapping, minimizes SQL coding, and improves application maintainability.

In addition, the integration of Java Mail API has enabled educational applications to send automated notifications regarding registrations, examinations, and certificate issuance, thereby improving communication between institutions and students.

Based on the review of existing literature, it is observed that very few systems combine student management, online course registration, QR code-based certificate verification, and email notification into a single platform. The proposed Student Management Course Registration System with QR Certificate Verification addresses these limitations by providing an integrated, secure, and user-friendly solution that enhances academic administration, ensures certificate authenticity, and improves the overall efficiency of educational institutions.

III. PROBLEM STATEMENT

Educational institutions still face several challenges in managing student information, course registrations, and certificate verification using traditional or partially computerized systems. Manual record maintenance requires significant paperwork, consumes considerable time, and increases the possibility of human errors such as duplicate records, incorrect data entry, and misplaced documents. These issues reduce the overall efficiency of academic administration and make it difficult to retrieve and update student information accurately.

Course registration is another critical process that often involves manual verification and documentation, resulting in delays and increased administrative workload. Students may experience difficulties in accessing course information, tracking their registrations, and receiving timely updates regarding enrolment status. Similarly, administrators spend considerable effort managing student records, monitoring course registrations, and maintaining academic data across multiple systems.

Certificate verification is also a major concern in educational institutions. Traditional paper-based certificates are vulnerable to forgery and unauthorized modifications, making it difficult for employers, universities, and organizations to verify their authenticity.

Manual verification procedures are time-consuming and require direct communication with the institution, leading to delays and additional administrative effort.

Furthermore, many existing student management systems do not provide integrated certificate verification or automated communication facilities, limiting their effectiveness in modern academic environments.

To overcome these limitations, there is a need for a secure, centralized, and automated system that integrates student management, online course registration, certificate generation, and certificate verification into a single platform.

The proposed Student Management Course Registration System with QR Certificate Verification addresses these challenges by providing role-based authentication, efficient database management using Hibernate ORM, secure QR code-based certificate verification, and automated email notifications. The system minimizes manual intervention, improves data accuracy, enhances certificate security, and provides a reliable and user-friendly solution for educational institutions.

A. Proposed System

The proposed Student Management Course Registration System with QR Certificate Verification is a web-based application developed to simplify and automate academic and administrative activities in educational institutions. The system integrates student management, online course registration, certificate generation, QR code-based certificate verification, and email notifications into a single centralized platform. It is designed using Java, JSP, Servlets, Hibernate ORM, MySQL, HTML, CSS, JavaScript, Bootstrap, and Apache Tomcat, following the Model-View-Controller (MVC) architecture.

The system provides separate login interfaces for administrators and students. Students can register, log in securely, browse available courses, enroll in courses, view their registered courses, and download course completion certificates. Administrators can efficiently manage student records, course details, registrations, and certificate generation through a dedicated dashboard. Hibernate ORM is used to establish efficient communication between the application and the MySQL database, ensuring secure and reliable data management.

A key feature of the proposed system is the QR Code Certificate Verification module. When a student successfully completes a course, the system automatically generates a digital certificate containing a unique QR code. The QR code is linked to the student's certificate information stored in the database. By scanning the QR code, employers,

educational institutions, or other authorized users can instantly verify the authenticity of the certificate, thereby prevent certificate forgery and reduce manual verification efforts.

The system also integrates the Java Mail API to send automated email notifications to students regarding successful registration, course enrolment, password recovery, and certificate availability.

Secure session management and role-based authentication ensure that only authorized users can access the application, thereby protecting sensitive academic information.

➤ Features of the Proposed System

- Student Registration and Login
- Administrator Login and Dashboard
- Course Management
- Online Course Registration
- Student Record Management
- Certificate Generation
- QR Code-Based Certificate Verification
- Automated Email Notifications
- Hibernate-Based Database Management
- Secure Session Management
- User-Friendly Web Interface

➤ Advantages of the Proposed System

- Reduces manual paperwork and administrative workload.
- Provides a centralized platform for student and course management.
- Enables secure online course registration.
- Improves data accuracy and minimizes human errors.
- Generates digital certificates with unique QR codes for instant verification.
- Prevents certificate forgery through QR code authentication.
- Sends automated email notifications to improve communication.
- Ensures secure access using role-based authentication and session management.
- Offers scalability and flexibility for future enhancements such as online fee payment, attendance tracking, and cloud deployment.

The proposed system provides a secure, efficient, and reliable solution for managing academic activities while enhancing certificate security and improving the overall efficiency of educational institutions.

B. System Architecture

The proposed Student Management Course Registration System follows a layered architecture in which each component is responsible for a specific task and communicates with other components through the application layer. This design simplifies system maintenance, improves

scalability, and enables easy integration of features such as QR code certificate verification and email notifications without affecting the overall application.

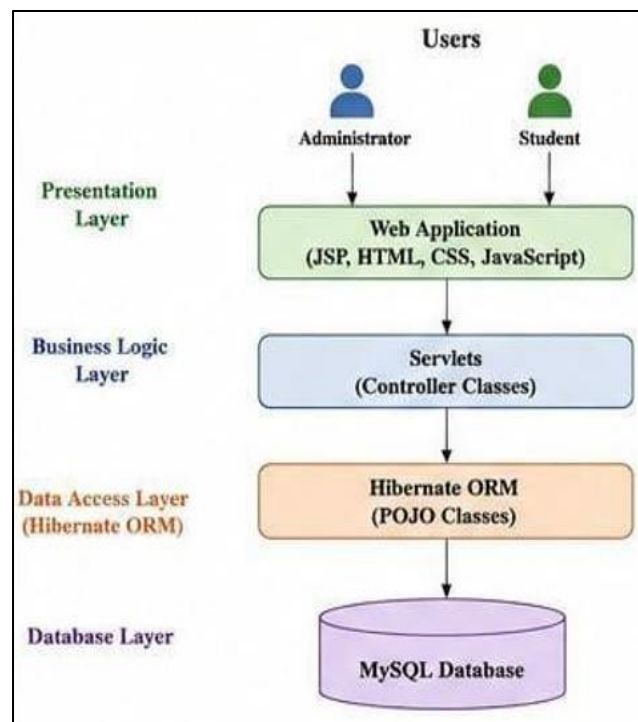


Fig 1 Overall System Architecture

➤ Module Description

• Presentation Layer

The Presentation Layer provides the user interface for both Students and Administrators. It is developed using JSP, HTML, CSS, and JavaScript. This layer allows users to register, log in, manage courses, view certificates, and interact with the system through a web browser.

• Business Logic Layer

The Business Logic Layer is implemented using Java Servlets, which process user requests and execute the application's core functionalities. It manages user authentication, student management, course registration, certificate generation, QR code generation, and email notification services.

• Data Access Layer

The Data Access Layer uses Hibernate ORM to establish communication between the application and the MySQL database. It performs Create, Read, Update, and Delete (CRUD) operations, manages database transactions, and simplifies object-relational mapping between Java classes and database tables.

• Database Layer

The Database Layer uses MySQL to securely store application data, including student details, administrator information, course records, registrations, certificates, and QR code information. It ensures data integrity, consistency, and efficient retrieval of information.

C. System Workflow

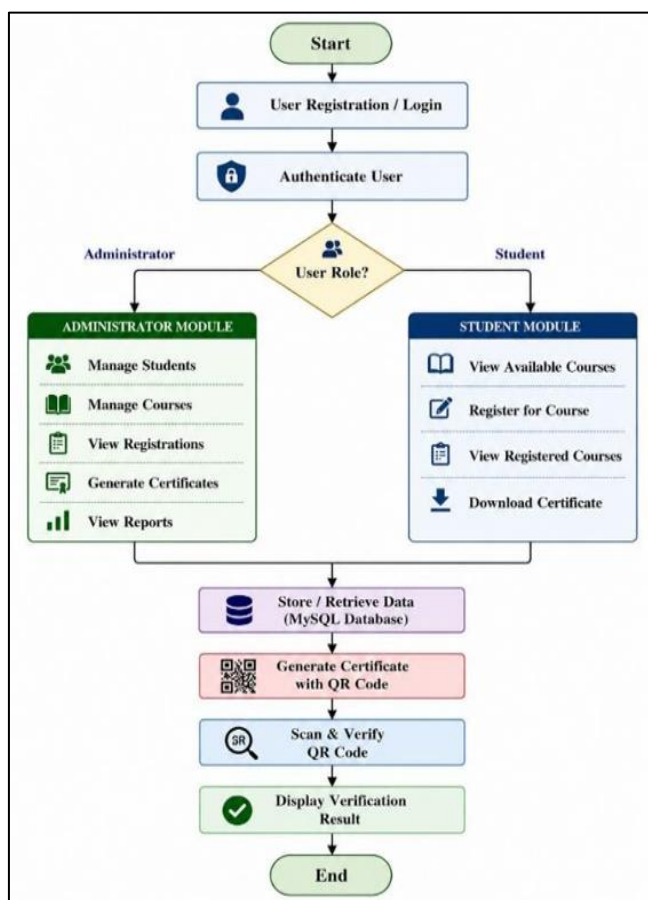


Fig 2 Flowchart

The Student Management Course Registration System with QR Certificate Verification operates through a sequence of connected modules that automate student management, course registration, and certificate verification. The workflow begins when a user registers a new account or logs into the system using valid credentials. The authentication module verifies the user's identity and grants access based on the assigned role, either Administrator or Student.

After successful authentication, students can browse the list of available courses, register for their preferred courses, view their registered courses, and download course completion certificates. Administrators can manage student records, maintain course details, monitor course registrations, and generate certificates through the administrative dashboard. All user requests are processed by the Java Servlet-based business logic and stored securely in the MySQL database using Hibernate ORM.

Once a student successfully completes a course, the system generates a digital certificate embedded with a unique QR code. The generated QR code contains a secure link to the certificate details stored in the database. Employers, educational institutions, or other authorized users can scan the QR code to verify the authenticity of the certificate.

The system retrieves the corresponding certificate information from the database and displays the verification result, ensuring secure and reliable certificate authentication.

Throughout the workflow, communication between the presentation layer, business logic layer, and database layer is handled in a structured manner to ensure data consistency and secure access. The modular design allows each component to function independently while maintaining smooth interaction with other modules. This architecture improves system reliability, simplifies maintenance, and provides flexibility for future enhancements such as online fee payment, attendance management, examination modules, and cloud-based deployment.

D. Implementation

The Student Management Course Registration System with QR Certificate Verification was implemented as a web-based application using Java, JSP, Servlets, Hibernate ORM, and MySQL. Java was used as the primary programming language, while Apache Tomcat provides the server environment for running the web application. The system follows a modular structure in which separate components handle authentication, student management, course registration, certificate generation, and QR-based verification.

The user interface was developed using JSP, HTML5, CSS3, JavaScript, and Bootstrap to provide a simple and responsive interface for students and administrators. Students can register and log in to the system, view available courses, register for courses, view registered courses, and access their certificates. Administrators can manage student records, course details, registrations, and certificates through the administrator dashboard.

The business logic is implemented using Java Servlets, which process requests received from the web interface and perform the required operations. Hibernate ORM is used as the data access framework to map Java classes with MySQL database tables. It performs operations such as inserting, retrieving, updating, and deleting student, course, registration, user, and certificate records. This reduces direct database interaction and provides structured data management.

The certificate module generates a digital certificate for a completed course and associates it with a unique QR code. The QR code is linked to the certificate information stored in the database. When the QR code is scanned, the verification process retrieves the corresponding certificate details and displays the verification result. This provides a convenient method for checking certificate authenticity and reduces the possibility of fraudulent certificates.

The application was developed and tested using Eclipse IDE, Apache Tomcat, and MySQL on a Windows environment. Each module was initially tested independently and then integrated into the complete application.

Functional testing was performed for user authentication, student management, course registration, database operations, certificate generation, and QR code

verification. The integrated testing confirmed proper communication between the application modules and reliable execution of the overall system workflow.

➤ Software Libraries and Technologies Used

Table 1 Software Libraries and Technologies Used

Technology/Library	Purpose
Java	Core Programming Language
JSP	Dynamic Web Page Development
Servlets	Business Logic and Request Processing
Hibernate ORM	Object-Relational Mapping
MySQL	Database Management
HTML5	Web Page Structure
CSS3	Interface Design
JavaScript	Client-Side Interaction
Bootstrap	Responsive Interface
Apache Tomcat	Web Server
ZXing Library	QR Code Generation
Eclipse IDE	Development Environment

IV. RESULTS AND DISCUSSION

The implemented Student Management Course Registration System with QR Certificate Verification was tested to evaluate its major functionalities and overall workflow. The system successfully provides separate access for students and administrators and integrates student management, course registration, certificate generation, and QR-based certificate verification within a single platform.

The student module allows users to register and log in securely, view available courses, register for selected courses, and access their registered course information. The administrator module provides facilities for managing student records, course details, registrations, and certificates. These functions reduce manual record maintenance and make academic information easier to manage.

The course registration module successfully stores registration details in the MySQL database through Hibernate ORM. The use of Hibernate simplifies database

operations and maintains consistent communication between the Java application and the database. The system also provides appropriate access based on user roles, helping protect administrative and student information.

The QR certificate verification module successfully generates certificates containing unique QR codes. When a QR code is scanned, the system retrieves the corresponding certificate information from the database and displays the verification result. This provides a faster and more convenient method of certificate authentication compared with manual verification.

The overall testing showed that the major modules function correctly and communicate effectively with each other. The system reduces administrative effort, improves the accessibility of student and course information, and provides an additional layer of security for digital certificates. The modular architecture also makes the application easier to maintain and provides a foundation for future enhancements.

Table 2 Functional Testing Results

Module	Expected Result	Observed Result
Student Registration	Student account created successfully	Successful
Student Login	Valid user authenticated	Successful
Course Registration	Course registration stored	Successful
Student Management	Student records managed	Successful
Course Management	Course details managed	Successful
Certificate Generation	Certificate generated with QR code	Successful
QR Verification	Certificate authenticity displayed	Successful
Administrator Login	Authorized administrator access	Successful

Table 3 Comparison with Traditional Approach

Feature	Traditional Approach	Proposed System
Student Management	Manual/Separate Records	Centralized
Course Registration	Manual/Offline	Online
Certificate Verification	Manual Verification	QR-Based

Certificate Generation	Paper-Based	Digital
Data Management	Manual Records	Hibernate + MySQL
Verification Time	Relatively High	Quick Verification

- Scalable Architecture: The modular design allows additional features to be integrated without major changes to the existing system.
- User-Friendly Interface: The web-based interface provides simple interaction for both students and administrators.

A. Advantages

The proposed Student Management Course Registration System with QR Certificate Verification provides several advantages over traditional academic management methods:

- Centralized Student Management: Student information, course details, registrations, and certificates can be managed through a single platform.
- Online Course Registration: Students can view available courses and register online, reducing manual paperwork and administrative effort.
- Secure Authentication: Role-based login provides separate access for students and administrators.
- Efficient Database Management: Hibernate ORM provides structured interaction with the MySQL database and simplifies CRUD operations.
- QR-Based Certificate Verification: Each certificate can contain a unique QR code, allowing quick verification of certificate authenticity.
- Reduced Certificate Forgery: QR-based authentication makes unauthorized modification or duplication of certificates more difficult.
- Reduced Manual Work: Automation of student records, course registration, and certificate generation reduces repetitive administrative tasks.
- Easy Information Access: Students and administrators can access required academic information through the web interface.
- Improved Data Consistency: Centralized database storage helps maintain consistent and organized records.

B. Future Scope

The proposed Student Management Course Registration System with QR Certificate Verification can be further enhanced to provide additional academic and administrative services. Future developments may include:

- Online Fee Payment: Integration of secure online payment gateways for course registration and other academic fees.
- Attendance Management: Addition of an online attendance module for students and faculty.
- Examination Management: Integration of examination scheduling, marks entry, and result management.
- Mobile Application: Development of Android and iOS applications for easier access to student and course services.
- Cloud Deployment: Hosting the system on cloud

platforms to provide scalable and remote access.

- Advanced Certificate Security: Integration of digital signatures or blockchain technology for stronger certificate authentication.
- Automated Reports: Generation of student, course, registration, and certificate reports for administrators.
- Enhanced QR Verification: Addition of certificate expiry, revocation, and verification history features.
- Role Expansion: Support for additional roles such as faculty, department administrators, and examination coordinators.
- Analytics Dashboard: Integration of analytics to provide insights into course registrations, student participation, and academic activities.

These enhancements can make the system more comprehensive and suitable for large-scale deployment in educational institutions.

V. CONCLUSION

The Student Management Course Registration System with QR Certificate Verification provides an integrated web-based solution for managing student information, course registration, and certificate authentication. The system automates important academic activities and reduces the limitations of manual record management. Students can register, access available courses, enroll online, and obtain their certificates, while administrators can manage student, course, registration, and certificate information through a centralized platform.

The integration of Java, JSP, Servlets, Hibernate ORM, and MySQL provides efficient application and database management. The QR code-based certificate verification feature offers a simple and reliable method for validating certificates and helps reduce the possibility of fraudulent credentials. The modular architecture also makes the system easier to maintain and extend.

Overall, the proposed system improves administrative efficiency, reduces manual effort, provides organized academic data management, and enhances the security and reliability of certificate verification. The system provides a practical foundation for further development and can be extended with additional academic and administrative features in the future.

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