



RESEARCH ARTICLE

ZEALOUS PRO-FOUNDRY: CLOUD-BASED CODING AND MCQ CHALLENGE HUB

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Manuscript Info

Manuscript History

Received: 23 January 2025

Final Accepted: 26 February 2025

Published: March 2025

Key words:-

MERN Stack, Cloud Computing, Real-Time Feedback, MCQ, Performance Analytics

Abstract

The evolution of online coding platforms has transformed the learning environment for programming students. However, existing platforms often lack comprehensive post-assessment documentation, detailed feedback, and performance reports. This paper presents the development of a cloud-based platform named Zealous Pro-Foundry, built using the MERN stack (MongoDB, Express.js, React, Node.js) to provide coding challenges, MCQ tests, real-time feedback, and auto-generated certificates under Digital Service Management System (DSMS). The platform aims to bridge the gap in practical programming education by offering interactive learning experiences and detailed performance analytics.

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Introduction:-

The demand for online coding platforms has increased significantly due to the need for programming skills among students. Current platforms lack real-time feedback, certification generation, and detailed performance analysis. This project, Zealous Pro-Foundry, aims to provide a dynamic and cloud-based coding and MCQ test platform with auto-certificate generation and performance reporting.

Existing coding platforms often lack real-time feedback and comprehensive documentation. This project addresses these limitations by creating a platform that provides instant feedback, automated certification, and detailed performance reports for educational institutions.

Objectives:-

1. Develop a cloud-based platform using the MERN stack for coding and MCQ tests.
2. Provide real-time feedback using a dynamic coding editor.
3. Generate certificates and detailed performance reports automatically.

Scope:-

The platform primarily targets educational institutions to enhance student engagement and provide real-time assessment.

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Significance:-

By integrating performance analytics, certification, and feedback in one platform, Zealous Pro-Foundry simplifies coding assessments and student performance evaluation.

Current coding platform provides an engaging environment for students to practice coding. This platform utilizes the MEVN stack (MongoDB, Express.js, Vue.js, Node.js) to offer both coding challenges and multiple-choice question (MCQ) tests. The frontend, built with Vue.js, ensures a dynamic and responsive user interface, while the backend, powered by Express.js, handles server-side logic and API requests. MongoDB serves as the database for storing user data and test results, and the Monaco Editor is integrated to provide a robust coding environment. However, the platform faces several challenges, such as delayed feedback, scalability issues, and a fragmented user experience due to the separate interfaces for coding and MCQ tests.

Literature Survey:-

The advancement of online coding platforms has significantly transformed programming education by offering learners diverse resources to practice and enhance their skills. Various studies have examined the development and impact of coding platforms, addressing gaps in real-time feedback, assessment, and performance analytics. Chandru et al. [1] discuss the design and implementation of an interactive coding platform aimed at addressing challenges faced by students, such as the lack of immediate feedback and structured assessment. The platform provides real-time coding exercises and post-assessment documentation, helping learners improve their coding efficiency. Furthermore, online coding platforms like LeetCode, HackerRank, and CodeChef provide competitive programming environments but often lack comprehensive performance analytics and instant feedback [1].

Hausladen et al. [2] propose a cloud-based integrated development environment (IDE) for embedded systems, which simplifies the development process by eliminating complex software setup requirements.

The cloud-based IDE allows for flashing and debugging embedded systems directly from a web interface, easing accessibility for students and professionals working on microcontroller-based projects. The emergence of web-based programming learning platforms has played a crucial role in improving coding education. Su et al. [3] present an interactive learning system that assists students in overcoming common programming errors. By integrating real-time error detection and correction, the platform enhances students' learning experience, providing a supportive and interactive environment for effective programming education. Database management is an essential component of modern coding platforms. Kanade et al. [4] analyze normalization and embedding techniques in MongoDB, demonstrating their importance in efficient data storage and retrieval in web applications. Their study highlights how these techniques improve query performance and scalability, which is crucial for developing large-scale coding platforms.

The social aspect of coding has also gained attention, particularly through platforms like GitHub. Thung et al. [5] investigate the network structure of social coding, analyzing collaboration patterns among developers. Their research reveals that open-source repositories play a vital role in knowledge sharing, collaborative problem-solving, and skill enhancement for learners and professionals alike. Zhang et al. [6] explore the implementation of software development course groups, emphasizing the importance of collaborative learning environments.

Their study suggests that integrating project-based learning methodologies into coding platforms fosters a deeper understanding of programming concepts and improves teamwork skills. Poulter et al. [7] present an implementation of a RESTful service using the MEAN (MongoDB, Express.js, Angular, Node.js) stack for the Internet of Things (IoT). Their study demonstrates how RESTful architectures facilitate seamless communication between distributed systems, which is beneficial for developing scalable online coding platforms. Ramu [8] introduces the IARE-BuildIT tool, an online coding platform designed to enhance students' programming skills. The platform incorporates structured learning paths, automated code evaluation, and performance tracking, ensuring that learners receive continuous feedback to improve their coding proficiency.

Chapman et al. [9] propose a strategy for monitoring and evaluating massive open online courses (MOOCs). Their research provides insights into effective assessment techniques that can be integrated into coding platforms to enhance learning outcomes and engagement.

Mobile-assisted learning has also played a significant role in coding education. Kukulska-Hulme and Shield [10] review the evolution of mobile learning tools, emphasizing the shift from content delivery to interactive and collaborative learning experiences. This transition has paved the way for mobile-friendly coding platforms that offer accessibility and flexibility for learners worldwide.

Limitations:-

1. Lack of Real-Time Feedback: Current platforms do not offer instant feedback, impacting the learning process.
2. Poor Scalability: Existing systems struggle to manage large user bases, resulting in system downtime.
3. Fragmented User Experience: Platforms have separate interfaces for coding and MCQ tests, causing inconvenience.
4. Limited Customization: Test creation and management lack customization options based on curriculum needs.
5. Security Concerns: Weak data security and user privacy measures lead to data breaches.
6. No Performance Analytics: Lack of detailed performance reports prevents institutions from analysing student progress effectively

Proposed System

The proposed system aims to address the limitations of the existing platform by developing a cloud-based coding platform using the MERN stack. The primary objective is to enhance the learning experience for students by providing real-time feedback on coding challenges and MCQ tests. The platform integrates the Monaco Editor to offer a robust coding environment with instant feedback, enabling students to quickly identify and correct mistakes.

The frontend of the proposed platform is built using React, ensuring a dynamic and responsive user interface that enhances user experience. The backend, powered by Express.js, handles server-side logic and API requests efficiently. MongoDB continues to serve as the database for storing user data, test results, and performance analytics.

Zealous Pro-Foundry Coding and MCQ Challenge Hub is designed to provide a seamless and efficient platform for conducting coding tests, multiple-choice questions (MCQ) assessments, and generating performance reports for students and administrators.

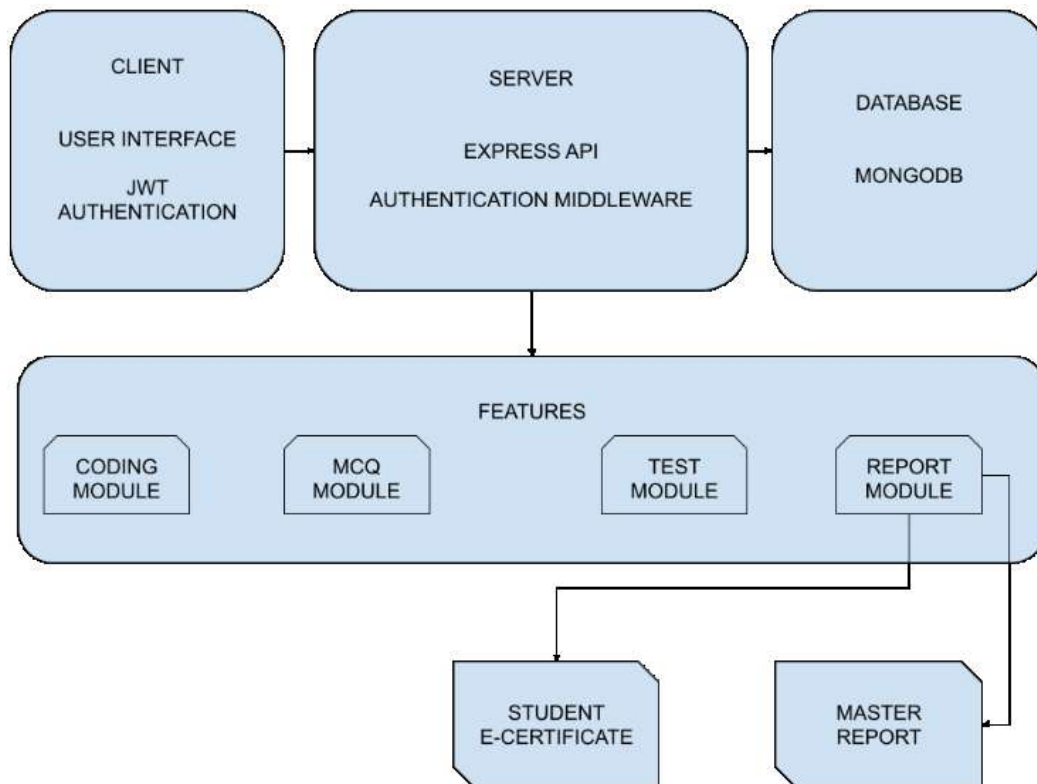


Fig:- Data Flow Diagram.

The client-side user interface acts as the primary access point where users (students and administrators) can log in, take tests, and view reports. The platform utilizes JWT (JSON Web Token) Authentication to ensure secure communication between the client and server, allowing only authorized users to access the platform. Once authenticated, the requests are handled by the Express.js API (Application Programming Interface), which acts as the core backend server that processes the incoming requests, handles business logic, and interacts with the database. The Arch Middleware plays a crucial role in validating incoming requests through JWT tokens and ensures data security before interacting with the MongoDB Database, where all data related to users, code submissions, MCQ submissions, test results, and generated reports are stored. The platform is divided into four major functional modules: the Coding Module, MCQ Module, Tests Module, and Report Generation Module. The Coding Module provides a code editor where users can write and execute code in various programming languages like Java, Python, C, and C++, and the system validates the code against predefined test cases before storing the results. The MCQ Module allows users to attempt objective questions and automatically validates the answers to compute scores. The Tests Module combines both coding and MCQ assessments into a single test, making the evaluation more comprehensive. Once the test is completed, the Report Generation Module processes the data and generates two types of reports: the Student Report and the Master Report. The Student Report provides a detailed performance summary including code execution results, MCQ scores, and areas of improvement, while the Master Report gives an overall performance summary of all students, helping administrators monitor and analyze student progress. This entire architecture ensures a seamless, fast, and secure testing environment by utilizing advanced technology stacks such as MongoDB for data storage, Express.js for server-side logic, and JWT Authentication for secure communication. The platform's modular approach improves scalability, maintainability, and real-time performance analysis, making it highly efficient for conducting large-scale coding assessments and skill evaluations.

Digital Service Management System

From the inflow map of the Digital Service Management System (DSMS), we can see the introductory inflow of information within the system. There are three key entities in the system. First of all, the users must register in the DSM using unique credentials by the admin. Also, it can be fairly divided into two corridors shown below facilitate coding assessments and MCQ tests for students. The system architecture consists of two major sections: Admin section with sub modules such as test, report, user, organization modules and all, where admins interact through a web browser using a React.js Application; User/ Student Section, where users can login and answer their test eventually see results.

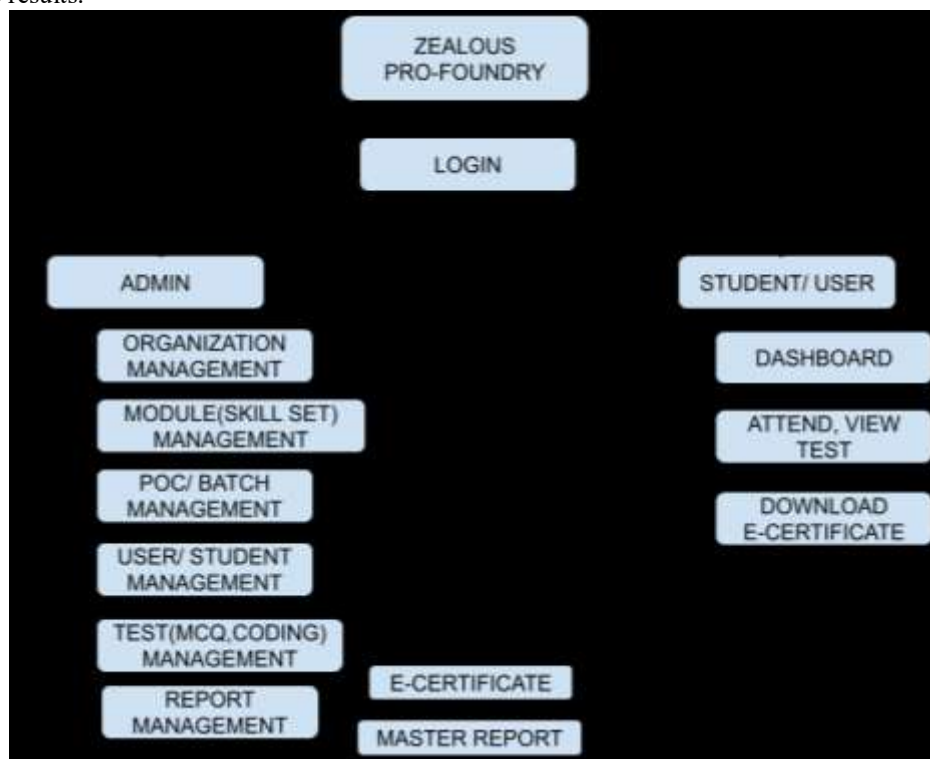


Fig:- Methodology.

Customer/Client Management:

The admin able to create/ add new organization along with module/ skill set training cum test to be organized for the specific client whom are considered to be college or any corporate company employees those who wish subscribe our service. In case of college, it may also have chances to conduct the same module to multiple departments which considered to be the batch where the users/ students were grouped and test's to be added for the specific batch.

Users and Expert Management

Admin has important feature to collect the student's information along with email in order to generate credentials for them to use while login to attend their test which has MCQ also Coding parts respectively. Expert who is trainer or resource person who deliver the training and conduct the test for the students, so admin has feature to include the expert's information of each batch with basic details such as name, profile and designation.

Test Module

The Test Module Section is responsible for conducting assessments. It consists of three major components: Coding Problems for programming challenges, MCQ Questions for theoretical tests, and a Code Execution Engine that executes code submissions and verifies output correctness.

Report Generation Section

The Report Generation Section is responsible for generating detailed performance reports. It provides Student Test Results, showing individual performance in tests, and Master Reports, offering overall insights into student performance across tests. This helps instructors and administrators evaluate overall learning outcomes.

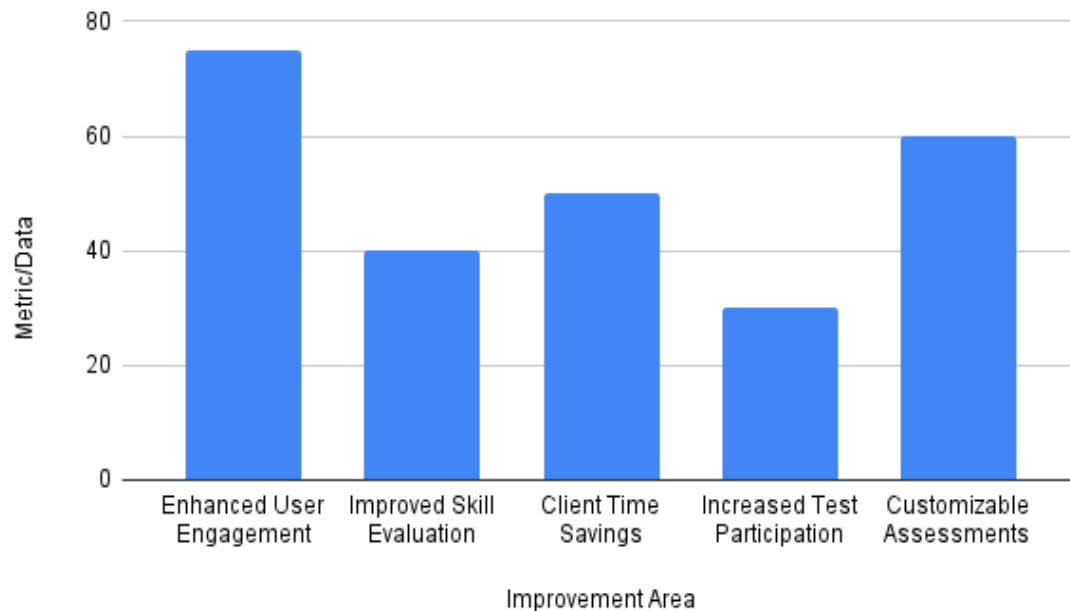
Advantages

1. Enhanced Learning Experience: The platform's real-time feedback
2. Scalability: The use of MongoDB, AWS ensures the scaling as needed.
3. Security: Robust security measures, including JWT authentication and data encryption, protect user data and ensure a fair testing environment.
4. Comprehensive Reporting: Detailed performance analytics provide educators with valuable insights, aiding in curriculum improvements and student assessment.
5. User-Friendly Interface: coding challenges and MCQ tests within a single platform.
6. Mobile Accessibility: The platform's fully responsive design ensures optimal usability across all devices, including mobile phones and tablets.
7. Customizability: The flexibility to tailor tests to specific educational needs and skill levels makes the platform versatile and adaptable.
8. Certificates and Reports: Automatic generation of certificates and detailed performance reports enhances the learning experience for students and provides valuable insights for institutions.

Results and Analysis:-

Improvement Area	Metric/Data	Impact/Result
Enhanced User Engagement	75% users reported increased engagement	Users find the combined format more interactive compared to platforms offering only one type of test.
Improved Skill Evaluation	40% better candidate accuracy in assessments	A mix of coding and MCQ tests evaluates both theoretical and practical skills comprehensively.
Client Time Savings	50% reduction in evaluation time	Consolidated testing format eliminates the need for separate tools, speeding up the hiring process.
Increased Test Participation	30% rise in test completion rates	Single-platform usability encourages candidates to finish tests without switching platforms.
Customizable Assessments	60% clients use adaptive difficulty features	Clients personalize tests based on roles, leading to better hiring alignment and satisfaction.

Analysis of Results



Conclusion and Future Enhancement:-

Cloud based MERN stack online coding platform addresses the critical shortcomings of current online testing platforms by integrating real-time feedback, seamless coding and MCQ tests, and comprehensive documentation features. The platform not only enhances the learning experience for students by providing instant feedback and auto-generated certificates but also offers detailed performance reports and analytics for educators, aiding in academic improvement. By leveraging the scalability, security, and user-friendliness of the MERN stack and deploying on AWS, the platform stands out as a robust and efficient solution for the educational technology sector.

Integration with Learning Management Systems (LMS): Enhance interoperability by integrating the platform with popular LMS such as Moodle, Canvas, and Blackboard. Offline Access: Develop offline capabilities that allow students to download coding challenges and MCQ tests, work on them without internet access, and sync their progress once they are back online.

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