Code Classroom (Assignment Based Coding Platform) using MERN

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Abstract—**In today's rapidly evolving educational landscape, providing students with hands-on coding experience has become increasingly essential for preparing them for future careers. This project introduces an innovative web application specifically designed to enhance the assignment, completion, submission, and evaluation of coding projects within classroom settings. The platform empowers educators to effortlessly assign coding tasks to all students, facilitating a more organized and structured learning environment. Students can write, test, and submit their code directly through the application, allowing for immediate engagement with coding concepts. The integrated coding environment supports various programming languages and includes features such as real-time testing, debugging tools, and collaborative capabilities, making the learning process both intuitive and interactive. For teachers, the platform streamlines the tracking of submissions and simplifies the review process. Educators can easily access students' code, assess their work, and provide targeted feedback and optimization suggestions. This fosters a continuous learning loop, where students can refine their skills based on constructive criticism. By combining a user-friendly interface with comprehensive evaluation tools, this web application aims to significantly enhance the overall learning experience. It not only simplifies the assessment process but also encourages a more engaging approach to coding education. Ultimately, the platform aspires to cultivate essential coding skills in students, preparing them for success in a technology-driven world.**

Keywords-Coding education, Web application, Assignment management. Real-time testing, Collaborative learning

I. INTRODUCTION

As technology advances, the demand for coding skills continues to climb, driving educational techniques to evolve and adapt to meet these growing needs. Online coding education platforms offer dynamic and stimulating settings that allow learners to advance their programming abilities at their own speed, circumventing distance constraints and satisfying different learning preferences. These platforms address the particular difficulties faced by people who do not have access to traditional in-person training by giving students the chance to practice coding in a more dynamic and customized fashion.

The rapid growth of the tech industry has resulted in a large skills gap that traditional educational institutions are finding difficult to fill, necessitating the creation of virtual coding courses. Due to time, money, or location restrictions, a lot of professionals and students look for alternate learning opportunities. Online tools that are affordable and accessible for students of different ability levels are essential in closing this gap. This digital strategy promotes diversity in the computer industry by catering to a diverse range of backgrounds and democratizing access to coding education.

These platforms enable students to take more ownership and responsibility for their education by letting them work at their own speed. Students learn better when they receive timely feedback from peers and teachers, which enables them to recognize their errors and make improvements. Peer review system integration promotes cooperation and teamwork, which are critical abilities in today's tech settings. According to research, online learning environments are a beneficial choice for coding instruction since they can provide better information retention and enhanced engagement when compared to traditional classroom settings.

This essay investigates the planning, execution, and results of an online course in computer programming. With an emphasis on developing a successful framework for coding instruction, it addresses the advantages, difficulties, and potential future applications of such platforms. This research adds to the existing discussion on optimizing online platforms for coding education by highlighting user involvement, curriculum flexibility, and strong assessment procedures. In order to ensure that these platforms continue to be powerful, relevant, and

accessible in the years to come, the aim is to provide insights into how they might be further improved to suit the changing expectations of learners and the tech sector.

II. NEED FOR PROJECT

Coding abilities are in high demand in today's technologically advanced world. With enterprises depending more and more on software solutions, it is imperative to provide students with competent code instruction. Traditional classroom environments frequently fail to give students enough practical experience and prompt feedback, which leaves a vacuum in the development of critical skills.

A. Skills Gap

The computer industry is experiencing a severe lack of skilled workers, which emphasizes how urgent it is for universities to improve their coding programs. The growing demand for students to gain real-world coding experience to prepare for future employment is addressed by this project.

B. Interactive Learning Environment

Numerous teaching tools now in use are ineffective at engaging students because they lack interactivity. This project attempts to create a more engaging learning environment by offering a web application that combines coding challenges with real-time testing and collaborative capabilities.

C. Streamlined Assessment

Teachers frequently struggle to effectively manage assignments and provide feedback. By streamlining the submission and evaluation process, this platform frees teachers to concentrate on providing helpful criticism and encouraging student development.

D. Accessibility

It is critical to develop accessible coding environments that accommodate a range of learning backgrounds and styles as online learning becomes more common. An inclusive platform that supports a range of programming languages and skill levels is offered by this project.

E. Future Career Readiness

This project gives students the necessary hands-on coding abilities to succeed in a fast-changing employment market and ensures they are prepared to take on real-world difficulties.

III. LITERATURE REVIEW

It's more important than ever to have strong coding abilities in this fast-paced technological age. To meet this need, educational approaches must change, which will lead to the creation of virtual coding classrooms that give students flexible, engaging surroundings. These online learning environments allow students to develop their programming skills at their speed, overcoming distance and accommodating a range of learning styles. Aspiring programmers can obtain a multitude of information from online resources that may not be offered by conventional educational establishments.

A. The Importance of Coding Education

Teaching students to program has become more and more important as technology affects many facets of life and the workplace. Coding education encourages computational thinking—an essential talent that incorporates problem-solving and logical reasoning, related to critical thinking and creativity. With this skill set, students can solve challenges in the real world and navigate intricate digital settings creatively.

B. The Role of Technology in Education

Traditional teaching methods have changed as a result of technology's inclusion in schools. The controlled environment that CodeClassroom and similar platforms offer for code submission, assignment management, and evaluation improves the coding experience. These resources not only help students learn but also promote teamwork, which increases the interest and interactivity of coding.

C. MERN Stack: A Comprehensive Framework

The MERN stack, which consists of Express.js, React, Node.js, and MongoDB, is a well-liked option for creating online applications since it uses JavaScript at every level. Developers may concentrate on creating features instead of juggling multiple programming languages because of this homogeneity, which streamlines the development process. Each element is essential to the whole:

- MongoDB: An adaptable JSON-formatted NoSQL database for storing data.

- Express.js: An API generation and server-side development platform for web applications.

- React is a front-end package that makes it possible to create dynamic user interfaces.

- JavaScript can be performed on the server side using the Node.js runtime environment.

D. Benefits of Using MERN in Code Classroom

- Scalability: As user needs change, MongoDB's adaptable schema makes modifications simple.

- Unified Language: Using JavaScript in all layers makes development easier and minimizes the need for developers to transition between contexts.
- Rich User Interfaces: React makes it possible to design responsive, dynamic user interfaces that increase user interaction with interactive components.
- Real-Time Functionality: Node.js enables real-time collaboration features, vital for a platform built to facilitate group work among students.

E. Difficulties with Implementation

- Performance Optimization: It can be difficult to make sure the program runs smoothly when it is heavily loaded during periods of high usage.
- Security Concerns: In a setting where students submit their code, safeguarding user information and averting code injection attacks are essential.
- Considerations for Project Management: Successful project management is essential to the creation of web apps such as Code Classroom. Important elements consist of:
- Agile Methodologies: Putting agile principles into practice makes it easier to create iteratively and enables quick adjustments in response to user feedback.
- Continuous Testing: Regular testing throughout the development cycle helps uncover issues early.
- Collaborative Coding Platforms: Node.js has shown to be an efficient way to manage multiple connections at once when used in applications that enable users to collaborate in real-time.
- Online learning environments: Real-time feedback methods that improve user engagement and learning results are integrated into platforms such as Codecademy.

IV. METHODOLOGY

A. Overview

The Code Classroom platform is designed to facilitate online coding education by offering a smooth interface where teachers can build classes, assign code tasks, and evaluate student contributions. Using an embedded code editor, students can join these classes, finish assignments, compile their code, and submit it for review. The MERN stack is used in this project to deliver an interactive and scalable experience.

B. Technological Stack

The project utilizes the MERN stack, which consists of:

- MongoDB: A NoSQL database used to hold student submissions, assignments, instructor evaluations, and classroom data.
- Express.js: A web framework for Node.js that handles server-side routing and API administration.
- The front-end framework React.js is in charge of maintaining the state between professors and students as well as rendering the user interface.
- Node.js: The server environment that uses the proper compilers to process requests and compile submitted code.

C. System Architecture

The architecture of the system is client-server:

- Frontend (React.js): The frontend gives teachers and students an easy-to-use interface. Code editors, assignments, and classrooms are dynamically rendered using React.js. In order to obtain and submit data, it communicates with the backend APIs.
- Backend (Express.js + Node.js): The backend is in charge of handling user data, assignments, and classrooms. It has an API with endpoints for creating classrooms, submitting assignments, and compiling code that links the front end to the MongoDB database.
- Database (MongoDB): This database holds organized information on users (teachers and students), including assignments, code submissions, classroom information, and feedback. The platform's flexible storage of a wide variety of data structures is made possible by MongoDB's NoSQL nature.

Because the platform is modular and each component communicates with the others via RESTful APIs, scalability and concern separation are guaranteed.
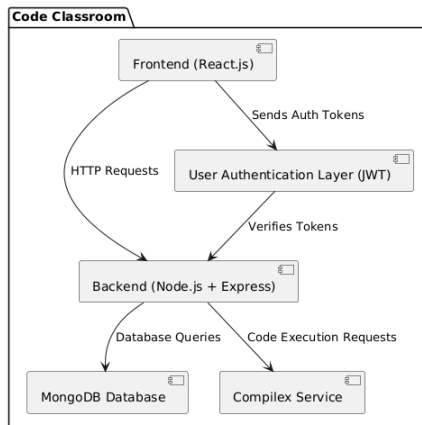
Fig. A - System Architecture

D. Code Compilation and Execution Workflow

The embedded code editor and compiler in CodeClassroom is one of its main features. The following is the workflow for gathering and running student code:

- Code Editor: The platform has an integrated text editor where students create their own code.
- Submission: The code is transmitted to the backend along with metadata, like the submission timestamp and the programming language used, when it is submitted.
- Integration of Compilex: The code is compiled and run in a secure, isolated environment by the backend using Compilex. Compilex guarantees that the code executes in a controlled environment, preventing malicious execution, and supports Python, Java, and C++.
- Results of Execution: The front end receives the compilation output (success, errors, or runtime output), which is displayed in real-time to students. Students can quickly iterate and correct their code thanks to this feedback loop.
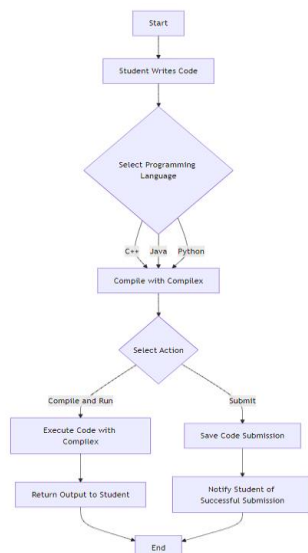

Fig. B - Code Compilation Flowchart

E. Classroom Management

- Teacher Interface: Instructors can set up classes in which they give out coding assignments. With the help of an easy-to-use dashboard, they can check student submissions, gather and examine the code, and offer thorough feedback.
- Student Interface: Students can write code directly on the platform, check their classes and assignments, and get immediate feedback on their work. They have access to the assignment statuses (reviewed, submitted, pending, etc.).

F. APIs and Communication

The front end and back end of the platform communicate with each other via RESTful APIs. APIs deal with:

- Classroom management: It includes setting up classes, adding students, and uploading assignments.
- Coding assignment submission, retrieval, and grading are all part of assignment management.
- Code Compilation: Requests for code compilation are handled by Compilex, which is contacted via backend APIs. Compilex returns the results in real-time to the front end.

G. User Authentication and Authorization

Secure access control is ensured, and user authentication is performed via JWT (JSON Web Token). In order for students and teachers to access their individual dashboards, they must first authenticate. With role-based access control, Students are limited to finishing and turning in their own work, but teachers are still able to oversee classes and assignments.

H. Testing and Debugging

- Frontend Testing: To verify the dependability of UI elements and user processes (e.g., turning in assignments, and attending classes), tools like Jest and React Testing Library are employed.
- Backend Testing: Postman is used to test API endpoints in order to ensure that they are correct and functional.
- Code Execution Testing: Compilex is used to run a range of test cases in order to verify error handling and overall performance as well as correct

compilation and execution of C++, Java, and Python code.

V. FUTURE SCOPE

The CodeClassroom platform presents a number of promising avenues for further development and improvement.

- Assistance with Extra Programming Languages: By adding support for well-known and up-and-coming programming languages like Python, Kotlin, and Swift, as well as AI and data science languages like R or Julia, the platform will become more flexible and broadly useful in a variety of industries.
- AI-Driven Feedback and Help: By incorporating AI to offer students automatic code assessments, real-time debugging support, and personalized feedback, the learning process will be improved and they will be able to get immediate, customized help.
- Gamification and Engagement: Adding gamification elements to the platform, like accomplishment badges, leaderboards, and coding challenges, can increase student motivation and engagement while also making it more engaging and entertaining.
- Mobile and Offline Access: By creating offline features and mobile app versions, educators may provide students with the opportunity to complete assignments and practice coding even when they don't have an internet connection. This will increase accessibility and flexibility in the classroom.
- Integration with Industry technologies: Upcoming improvements may incorporate the platform with commonly used industry technologies, like continuous integration systems and GitHub, to better prepare students for real-world coding environments and teamwork on significant projects.
- Advanced Learning Analytics and Progress Tracking: Teachers will be able to deliver more individualized education if they use strong analytics to monitor student performance and learning trends. By identifying areas for improvement, teachers and students can improve overall learning outcomes with the aid of data-driven insights.

VI. CONCLUSION

By offering an organized, engaging, and expandable virtual learning environment that is customized for teachers and students alike, the CodeClassroom platform fills a significant vacuum in the field of coding education. The platform revolutionizes the management, submission, and evaluation of coding assignments by incorporating

essential features like real-time code testing, debugging tools, and collaboration possibilities. It makes it possible for students to get real-world experience and feedback in a way that encourages greater engagement and active learning, better equipping them to face the challenges of a future driven by technology.

The MERN stack, which consists of Node.js, React, Express.js, and MongoDB, allows the platform to seamlessly integrate front-end and back-end functionalities and provide a single development environment. By using this framework, developers can continue to expand upon the platform without having to move between multiple programming languages, which improves scalability even further. This facilitates more efficient iteration and development, allowing the platform to adjust to changing technical and pedagogical demands.

The educational value of CodeClassroom is found in its flexibility in meeting the needs of different types of learners. Students can work at their own pace and on their own schedules because the platform is available to them from anywhere. This adaptability is especially crucial for closing the skills gap that traditional educational institutions sometimes fail to provide—the practical coding experience required to succeed in today's labor market. By enabling students to write and test their own code as well as participate in peer evaluations and group projects, the platform encourages ownership of learning and helps students grasp coding ideas on a deeper level.

CodeClassroom makes it easier for teachers to handle assignments, keep track of submissions, and provide feedback. These typically time-consuming processes are made simpler by the platform's user-friendly interface and extensive evaluation capabilities, freeing up teachers to concentrate on providing focused feedback that promotes skill development. Teachers can make sure that students consistently improve their coding skills and fix errors by using real-time feedback mechanisms and an organized learning loop. This is crucial for long-term mastery.

To sum up, CodeClassroom is a huge advancement in the field of online coding instruction. Through the integration of an intuitive interface, all-inclusive assessment instruments, and instantaneous coding capacities, it serves as a link between conventional learning and the constantly

expanding needs of the technology sector. It gives teachers effective teaching tools, gives students the freedom to take charge of their education, and eventually equips aspiring tech workers with the knowledge and abilities needed to thrive in a quickly changing digital environment. The platform has enormous potential to influence coding education in the future and help close the skills gap in the tech industry as it develops.

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