Automated Programming Evaluation using MERN

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Abstract—**Understanding how software works and building code has been a basic requirement for every student. Programming skills vary from person to person and even from language to language. Monitoring the student performance is evident to assess and improve programming skills. Though e-learning courses have paved the way to a different structure of learning, it is way more important to practice under supervision. The proposed model aims to automate the process of lab evaluation and assessment of programming subjects in the curriculum. The basic idea is to bring the IDE of various programming languages(C, C++, Python, Java, C#, goLang, JS) to construct a single platform to write code. The automated platform consists of different types of modules. Faculty module can add, modify or delete questions. According to the sections and subjects allocated, the faculty can observe the performance trends of all the students of the section in a given language. Test cases will be provided for each question. In student module, the student will be able to see all the programming subjects according to the section. Percentage, grades and marks will be provided based on the completion of test cases. Student profile demonstrates the whole details of the student. In admin module, the admin will have access to the overall website, to add faculty and student details. This project is being built using MERN stack web development. This automated tool will be very useful in assessing the students and provide accurate results.**

Keywords—Programming, Software, Web development, Database,

MongoDB, React.JS, Node.JS, Express.JS

I. INTRODUCTION

Computer-based courses have become increasingly popular in recent years, and programming languages such as C, C++, Java, Python etc., are widely used in these courses [1, 5]. To improve their skills in these languages, students must attempt assignments on a regular basis, and it is important to have access to tools and web applications that can test and grade their programming abilities [6]. While there are many tools and web applications available for evaluating programming issues in languages like C, C++, Java, and Python, there is currently a lack of online tools for evaluating Scala programming issues. This can be a major drawback for students and programmers who are trying to improve their programming skills. One possible solution to this problem is the development of a web-based automatic programming evaluation tool. Such a tool would allow programmers to test their code against a fixed set of programming issues, and receive immediate feedback on their performance. This would not only save time, but also help programmers to identify and correct errors more quickly. To develop a web-based automatic programming evaluation tool, it would be necessary to have a thorough understanding of the language and its syntax. This would involve creating a set of test cases that cover all the key features of the language, and building a system for compiling and running code against these test cases. The automated programming evaluation using MERN is a precious tool for students, faculty, and educational institutions. It allows students to exercise programming languages and see their results, making it easier for them to improve their skills and track their progress. Faculty can conduct practical sessions with ease, and the results are streamlined automatically, making it easier to estimate students' performance and track their progress. MERN is developed as MongoDB, Express JS,React.JS and Node.JS in which server client architecture is maintained. MERN mound development provides support to both front- end and back-end app development. Then front-end technologies like React.JS, HTML, and Tailwind CSS are used and back-end technologies like Express.JS, Node.JS and MongoDB are used [10]. Tailwind is a CSS framework that is used for fast development of custom user interfaces by providing a set of predefined classes that can apply directly to applications. Tailwind CSS includes a comprehensive set of classes for working with various types of materials, such as buttons, cards, forms, and more. MERN stack is a JS stack that is used for simple and quick classification of full-mound web operations. The MVC armature separates the demonstration details from the business sense, making it easier to maintain and modernize the operation. The database schema is enforced to store student and faculty data, making it easy for the admin to pierce and manage the information. The operation is stoner-friendly and accessible to different users such as students, faculty, and admin. To enable web pages to load content, need to ensure that your web server is running and properly configured to handle HTTP requests. You also need to ensure that your web pages are properly coded with valid JavaScript, and that any external resources such as images,

videos, and scripts are properly linked and accessible. Optimizing images and minimizing HTTP requests can also improve page load times. To handle HTTP requests, need to set up an HTTP server that listens for incoming requests and processes them according to the HTTP method and requested resource. The server should also handle error responses and return appropriate status codes. The admin has full access to the students and faculty data, allowing them to manage and track the progress of students and faculty [4]. Students results are recorded manually by the faculty, this is a difficult task and time consuming. Even in existing system there were some coding platforms for students to practice coding but the drawback is that it may not give accurate results to update automatically. Coding platform that should be able to test with various inputs, compile programs and execute it quickly. But the limitation in existing system is that, to monitor and generate results is a time consuming task. Therefore the automated programming evaluation using MERN is an effective tool for educational institutions to track students performance and estimate results. It provides a platform for students to exercise programming languages and improves their skills, making it easier for them to pursue careers in specialized sectors. The use of MERN mound development makes the operation easy to maintain and modernize, icing that it remains applicable and effective in the future.

II. LITERATURE SURVEY

The paper presents a MERN stack-based Education Management Information System (EMIS) for Pacific Island countries. The authors highlight the need for such a system to improve education management and outcomes in these countries. They discuss the challenges faced during the development of the system, including limited internet connectivity and lack of technological infrastructure [1]. Automated Grading Systems for Programming Assignments propose a system that integrates natural language processing and machine learning techniques to grade programming assignments automatically [2]. The MERN stack was selected for its scalability, flexibility, and ability to handle large volumes of data [4]. The platform is designed to help students learn programming concepts, practice coding, and receive automated feedback on their code. The automated assessment component is based on a set of predefined tests that evaluate the correctness of the code, while the peer learning component allows students to work together, share knowledge and give feedback to each other [5]. College ERP system using the MERN stack, the authors highlight the need for an efficient and comprehensive system to manage various college activities, including student records, academic calendars, and examination results [6]. The MERN stack, which comprises MongoDB, Express.js, React.js, and Node.js, is used to develop the applications. The authors explain the features and functionalities of the system, including student registration, attendance management, fee payment, and library management. The system is evaluated through user acceptance testing and found to be effective in streamlining college operations [7]. The application includes features such as student registration, course selection, attendance tracking, and grade management [15]. An automated programming evaluation system requires a robust and efficient web application that can handle large amounts of data and provide real-time feedback to students and instructors [16].

III. CHALLENGES WITH PRIMARY WEB APPLICATIONS AND THE PRESENT WEB APPLICATIONS

The application of web technology in programming evaluation has been made possible by the ability to manage data and information effectively. However, early web solutions faced challenges with low user satisfaction due to the synchronous model of web application development. This model caused delays in page rendering and made the user experience different from that of desktop applications [14]. The emergence of Ajax in 2005 addressed this issue and introduced asynchronous interaction in web applications, improving page rendering performance and creating a strong challenger to java base desktop applications. This led to the development of web 2.0 applications that allowed for dynamic web pages and responsive web design. The introduction of the built-in XML HTTP Request "fetch()" function within JavaScript around 2017 enabled web pages to load content onto the screen without the need for page refreshes, facilitating the execution of Ajax in web applications. Today, web-based application development has undergone significant transformation, with the development of cross-platform, high-performance, and open-source frameworks such as ASP.NET Core, Ruby on Rails, Cake PHP, Laravel, Aftertaste, Spring Web MVC, Django, LAMP stack, and MERN stack. These frameworks allow for the creation of web applications that can adapt to users' technology platforms, personal preferences, screen resolutions, and internet connection speed. Overall, the evolution of web application development has enabled more efficient and effective management of data and information in educational management, leading to improved user experiences and greater flexibility in accessing and sharing information [8,12,19].

IV. MATERIALS AND METHODS

A. Three Tier Architecture:

Three tier architecture where web browser requests a resource and a response is generated from a database. This three tier architecture helps in handling of complex distributed database applications. Three tiers that each run on a different platform the first tier is client/ web browser, it contains user interface and in this project React.JS is used for developing UI, second tier is the application server it provides application logic and data processing functions, Express.JS and Node.JS are used in server side implementation and the third tier consists of DBMS that run on a server called a database server, where MongoDB is used for handling databases. The 3 layers called in a three-tier client/server architecture are presentation layer, application layer, data layer. Presentation layer is responsible for the user interface, which includes the presentation of information to the user and the collection of user input. Application layer contains the business logic and application code that processes requests and manages data. Data is responsible for managing the data and data storage.

B. MERN Stack:

MERN represents the three tier architecture that has a front end, back end, database and can be constructed completely using JS and JSON [4,7]. MERN consists of three tiers are client-side, server-side and database tier.
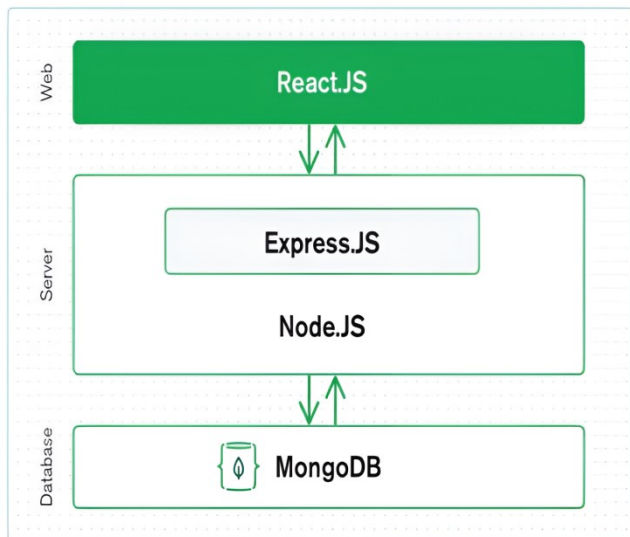
Fig. 1.MERN Architecture

a) React.JS

React uses a virtual DOM (Document Object Model) which optimizes updates to the real DOM, making updates much faster and efficient. React also provides a way to manage the state of an application and share data between components. This makes it easier to build complex and scalable applications. React is also highly modular, meaning that developers can easily reuse components and build large-scale applications with ease. It also supports server-side rendering, which makes it possible to build fast, responsive and SEO-friendly applications. React is a popular choice for building modern web applications and has a large and active community that provides regular updates, bug fixes and new features. This has led to the development of many popular libraries and tools such as React Native, React Router, and Redux, which help developers to build more sophisticated and powerful applications. Overall, React is a powerful, flexible and efficient tool for building modern web applications and has quickly become one of the most popular JavaScript frameworks in use today [15].

b) Node.JS

A JavaScript runtime that allows you to run JavaScript code outside of a browser. It comes with a set of built-in modules and a package manager called npm that lets you install third-party packages. Node.JS is highly optimized for high performance and can handle large amounts of details. It also utilize an event-driven, non-blocking input-output model, which indicates that it is ideal for building scalable, real-time web applications. This model enables Node.JS to handle multiple connections simultaneously without blocking the main thread, making it possible to build highly responsive applications. In addition to its performance, Node.JS has a large and growing community of developers who contribute to its development and provide support. There is a wealth of third-party packages and modules available for Node.JS, which makes it easy to extend its functionality and add new features to your applications. Overall, Node.JS is a powerful and versatile platform for building web applications, and is

well-suited for a wide range of use cases, from small, simple applications to large-scale, complex systems.

c) Express.JS

A popular web framework for Node.js that provides a set of features and tools for building web applications. It simplifies the process of creating routes, handling HTTP requests and responses, and integrating with other middleware and components. To build a full-stack web application using these MERN components, would typically create an Express.JS server that handles HTTP requests and routes, and that connects to MongoDB using the MongoDB Node.JS driver. Then can create a React.JS client that uses XML HTTP Requests or other HTTP methods to communicate with the server and retrieve data from MongoDB [20].

d) MongoDB

A NoSQL document-oriented database that is designed for scalability, performance, and flexibility. It uses JSON like documents to store data, and it has a rich set of features for querying, indexing, and aggregating data. It's an open-source database and can be used as an alternative to traditional relational databases, especially for working with large, distributed data sets. MongoDB provides features like database creation, schema definition, and collections management, and offers a JavaScript-based shell for querying, updating, and deleting records [4,13].

C. Collections in automated programming evaluation:

Collections are depicted in relationship diagram it describes the relation between collections. Collections have relations like one to one, one to many and many to many as shown in fig. 2. Admin maintains one to many relation with faculty and students and admin dashboard, profile have one to one relation. Students maintain many to many relation with subjects and many to one relation with compiler. Faculty maintain one to one or many relation with subjects and results. Subjects, questions and results maintain many to many relationship [1,2].
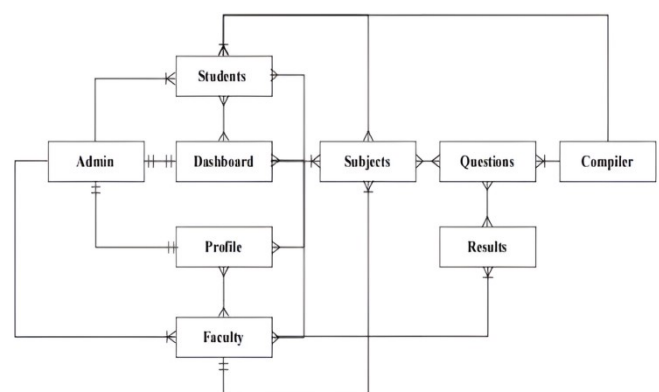

Fig. 2.Relationship diagram

TABLE.1. AUTOMATIC PROGRAMMING EVALUATION COLLECTIONS DESCRIPTION

Collections	Description
Admin	Collection contains details of Administrative, admin has complete access level for website and login credentials will be provided.
Students	This collection contains student details, tasks, marks.
Faculty	Consists of faculty details, students details.
Profile	Consists of individual admin, faculty and student details.
Dashboard	This collection contains details of subjects, marks, edit options, questions.
Subjects	Subjects details provides efficient subject allocation to faculty and students, available on dashboard
Questions	Programming questions that students solve, and faculty will add questions.
Compiler	Platform students will execute their programming questions
Results	Captures students marks as per their performance, stores results and share details to faculty and admin.

D. Classes consisting of modules data and methods:

The figure 3 describes the classes like student, admin, faculty, subjects, questions, compiler, results. These classes shows data stored in each of them and methods followed by each class [1].
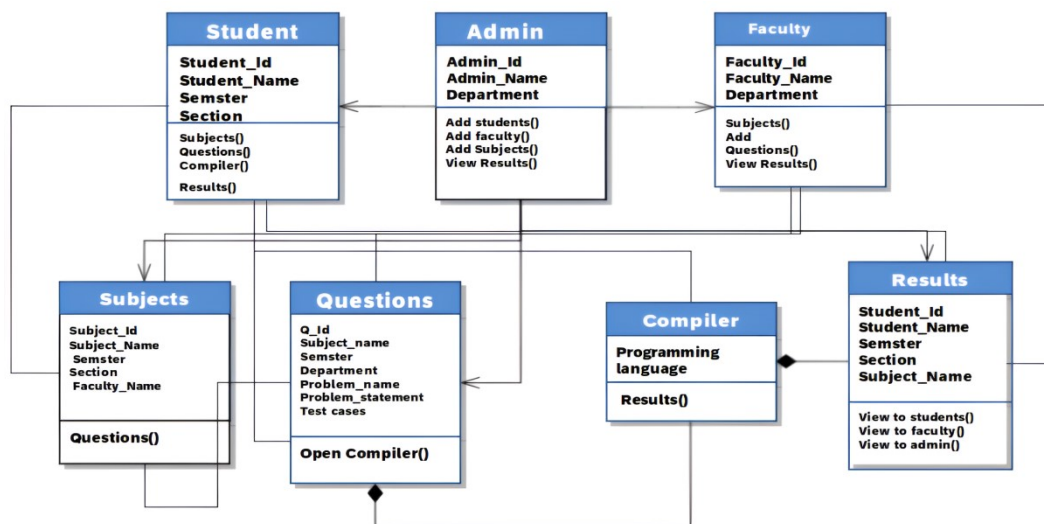

Fig. 3. Class diagram

TABLE.2. LIST OF MODULES

Module 1	Admin module
Module 2	Faculty module
Module 3	Student module
Module 4	Compiler module

1) Admin module:

In admin module, the admin will have access for the overall website. Admin can add faculty and student details. There will be edit option to modify details. The module contains admin profile, dashboard. Profile include details of admin and in dashboard, appears all the information about faculty and students.
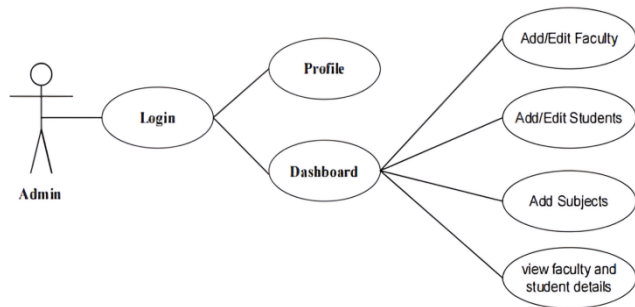

Fig. 4.ADMIN MODULE

2) Faculty module:

Faculty module consists of profile and dashboard. Dashboard have information about subjects, students performance and profile have faculty details. Here faculty will assign tasks to students and they can also check students performance.
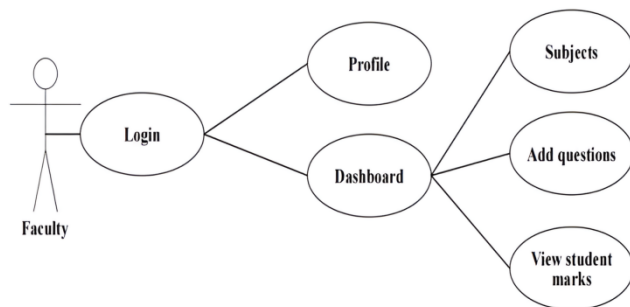

Fig .5. FACULTY MODULE

3) Student module:

Student module consists of profile to know the details of students and dashboard have information about programming questions, results. Students after completion of tasks can see their results, that will be displayed in dashboard [16].
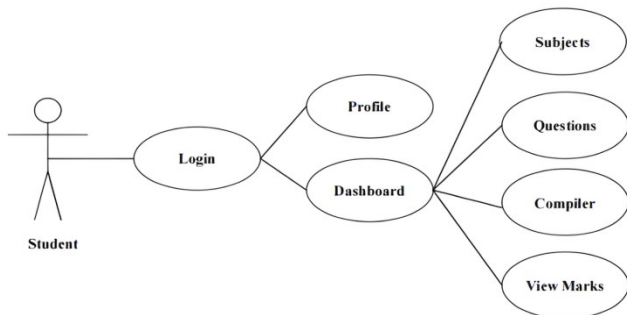

Fig .6. STUDENT MODULE

4) Compiler module:

Compiler module consists of all programming languages in one platform. Students will execute programming questions in this platform. There will be test cases depicted for each questions, according to the test cases passed results will be generated for students.

E. Database System:

The main difference between SQL and MongoDB is that SQL is a relational database management system that stores data in tables with predefined schemas and supports structured querying using SQL language, while MongoDB is a document-oriented database that stores data in flexible, schema-less documents and supports querying using a JSON-based query language. Database system, figure 5 describes how data is stored and accessed by each module. Each collection maintain different database [9,18]. Data is typically stored in a mongo database and accessed by each modules through input/output operations. Each module have its own specific data requirements and data processing logic, which determines how the data is accessed and utilized within the module.
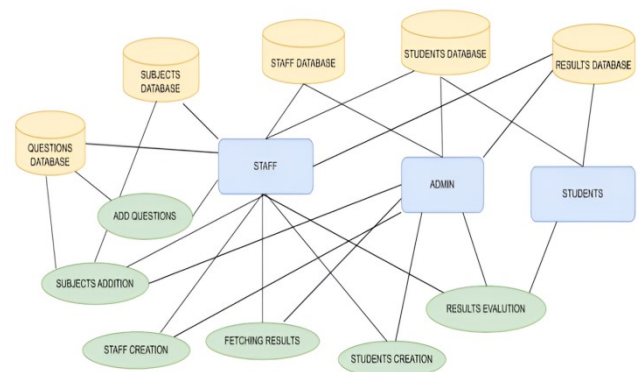

Fig.7. Database system

F. Back-end Deployment and Hosting:

Deploying a web application involves moving code from a local computer to a public host (server) so that it can be accessed by clients. Web hosting is a service provided by web hosts, which includes web space for storing data and a domain name. MongoDB Atlas is a cloud-based platform for running MongoDB databases and is used in this project for deploying the web application. The MongoDB document model is flexible and allows for easy modification of the schema as new features are added to the application. Render is the web hosting provider used for this project. Web hosting is a computer that stores the website files and makes them accessible to others over the internet[11,17].

CONNECT.JS (CONNECTION):

```
const mongoose = require('mongoose')
const connectDB = (url) => {
  return mongoose.connect(url, {
    useNewUrlParser: true,
    useCreateIndex: true,
    useFindAndModify: false,
    useUnifiedTopology: true,
  })
}
module.exports = connectDB
```

V. RESULTS AND DISCUSSIONS

Automated programming evaluation refers to the use of computer programs and tools to assess the quality and correctness of programming code submitted by students. It involves the use of automated testing frameworks and tools to evaluate the code's functionality, efficiency, and adherence to programming principles and standards. In this application after successful implementation it works effectively for programming evaluation and related outputs, description is showed in table 3

TABLE.3. RESULTS BASED ON TESTING

Input	Output	Description
Admin Registration	Registration Successful	Admin profile will be created when admin sign up with correct credentials
Admin Registration	Registration Unsuccessful Alert: Email Id already exists	Admin profile will not be created when admin tries to register with already existing Email address.
Student Login	Login Successful	Student page will be opened when student login with correct credentials
Student Login	Login Unsuccessful Alert: Email Id is required Password is required(or) Incorrect email, password	When student try to login with incorrect credentials then student page will not open and shows Alert message.
Faculty Login	Login Successful	Faculty page will be opened when faculty login with correct credentials
Faculty Login	Login Unsuccessful Alert: Email Id is required Password is required(or) Incorrect email, password	When faculty try to login with incorrect credentials then faculty page will not open and shows Alert message.
Get Student details	Student details will be displayed.	Student information will be displayed to faculty and admin when they search for student details.
Get faculty details	Faculty details will be displayed	Admin can see faculty details when search about faculty
Personalized Search	Display results, subjects details.	The user enters correct personalized key to search the content like results, subjects, questions.
Assigning Questions	Questions upload successful	Faculty assign questions to class
Solve Questions	Compiler Open	Students to solve questions, compiler will open.
Check Results	Student Result	Results will be evaluated based on test cases passed

VI. CONCLUSION

Automatic Programming Evaluation using MERN Stack provides an easy way to automate the evaluation of student performance. It is a platform that helps students to develop their programming skills. Students will run their programming questions on compiler and after executing of test cases that are provided, results will be generated. This process makes easy to faculty to monitor students performance. It provides reliability, time savings, and is easy to control. Information can be saved. It includes almost

all modules required for students and faculty to process their work.

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