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CODE-STEP: AI-Powered DSA Learning Platform

Manishankar Kumar[1], Mrs Divyashree R[2]

Computer Science and Engineering, The National Institute of Engineering, Mysuru, India[1]

Assistant Professor, Computer Science and Engineering, The National Institute of Engineering, Mysuru, India[2]

Abstract: The fundamental building blocks of Computer Programming are Data Structures and Algorithms (DSA). The DSA is a very important part of Software Development, Coding Competitions and Technical Job Interviews. [1] At present, there are several online resources where students can find a wide variety of DSA problems; however, the majority of these platforms do not provide systematic guidance on how to learn and practice DSA.
To address this issue, we have created CODE-STEP, an artificial intelligence powered DSA Learning System designed to make learning DSA much easier and more organized than other existing resources, as CODE-STEP presents to students a well-structured and step-by-step approach to solving DSA problems, as opposed to providing random selections. [3] CODE-STEP continually tracks each student's learning progress using performance metrics such as accuracy rates, number of attempts, and time required for completion for each problem they are working on.

In order for CODE-STEP to provide a streamlined, interactive, high-performance and user-friendly experience, we use modern technology such as React.js for front-end graphical user interface development; Node.js for back-end processing; MongoDB for data storage; and the Gemini API to provide AI assistance. CODE-STEP creates an encouraging and motivating environment for students to learn DSA without feeling overwhelmed by the amount of material that they need to learn.

Keywords: DSA Learning, Artificial Intelligence, Personalized Learning, AI Chatbot, Smart Recommendation System [5].

1. INTRODUCTION

A Data Structure is an organized method for storing and managing data; while Algorithms are instructions on how to use the data.
Data Structures and Algorithms define how efficiently and quickly a programmer can write computer applications.
Knowledge of either of these concepts can help students design better Algorithms, improve their ability to solve problems, decrease the amount of time it takes to execute a program and create solutions that can be used in the "real world."
For these reasons DSA is a core part of every Computer Science student's education, as well as a crucial part of any competitive programming event or technical interview[1] [4].
However, even though DSA is very important, many students do not understand DSA concepts due to the fact that they are primarily theoretical and require logical thinking and continuous practice to master. Most learning resources contain thousands of DSA-related problems and the number of students who can consistently complete these types of challenges is quite low.
Learning platforms usually only to you that you will learn subjects A to B to C, etc. They do not have any type of information on what order to learn them or which problem is next in sequence.
The majority of platforms have thousands of problems on them, but have little to no instruction on how to go from the easiest to the hardest level of learning, and therefore students rely heavily on external resources to find answers when they become confused by errors during the learning process; this greatly disrupts the learning cycle and creates unnecessary frustration.

CODE-STEP has been created specifically to try to eliminate those issues. Our mission is to provide an overall supportive and well-structured environment for learning, providing students with guidance and support while moving from the very basic concepts of arrays and loops to advanced techniques such as dynamic programming and graphing.
Each student is given a complete explanation of each problem, and through AI-based hints, students will receive additional assistance, as well as be provided with individualized recommendations based on their performance, creating an experience that is tailored to the individual needs of the student while enhancing their ability to learn quickly and with confidence.

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II. LITERATURE SURVEY

The application of technology suchas AI&ML, has been demonstrated through multiple research studies that provide positive outcomes forthe delivery of information to students enrolled in online degree programs, with significantly improved benefits through use of technology.[1,2] These technologies will enable more effective learning outcomes; both AI&ML will beneficially.
The most widely studied area in education technology has been the development and implementation of intelligent tutoring systems. Intelligent tutoring systems (ITS) are an alternative to traditional (in-person) tuitionsystemt, as theyprovideeach student with individulizedguidnaceand asswesome as necessity. ITS can provide studentsfeedback on performanceimmediateley.
Another area of research related to education isthedevelopment of "recommender" systems for learningcontent, which aidcon-centersinguptoerformcebdoneontdition-related issues, includingpriorpoolerofinterest grade level difficultycategores.[4,5,6]
Among otherareasrelatedtoeducationtechnologyresearch,thereareknowledgetrackingmodels, which is designed toidentify thestudys learner's knowledgedknowledge of whichexceptonnorre of everyhcknowleexist for the learner as learner throughmonitoring the learner andwithin an elogcal, as well asuit abptinyforyou t tobeidentified suffecsyet rounthed effdetohighlig nhed efinitelyy by analyyzgh zakresie,analze ropessg with knowledge smivenstricallybe alloligenarhyet fyou for lerbetween subjectand ulewith the studer'sidentify[7] . Thiselfuresatterag,repeatowers are woefullynecentacthroughoutthe useoftioniztandapin andsmich, (andulearningdirectctordofrdaay,whhtthereasonre[8])".

III.METHODOLOGY

CODE-STEP employs a client-server approach to allow users access to its platform via a browser. The user interface for CODE-STEP was designed using React.js for an appealing and engaging experience. [1]
The back end of CODE-STEP has been created through Node.js and Express.js to handle user requests and manage application logic. All user database entries relative to users, problem sets and performance history are stored in MongoDB [4].
Gemini API The AI assistant uses Gemini API to support users when they have questions regarding concepts in programming and to provide an explanation, suggestion, or optimized code to the user. This gives students a personalized, tailored learning experience and allows students to progress at their own speed, while not feeling rushed to complete their work. [8]

IV.IMPLEMENTATION

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User Authentication Module: The Authentication Module ensures that registered users can log on securely. After completing registration, the authentication module encrypts user passwords, creates a profile identifying each user, and securely stores both in its database. The creation of tokens keeps users on the platform when they are logged on, and only

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validated users will have access to the system. Once validated by the Authentication Module, users will have access to the Student Dashboard. Students who have logged into their accounts will be able to select Topic(s) for study, solve assignments from those topics, and track their progress in each of their addendums.

User Module

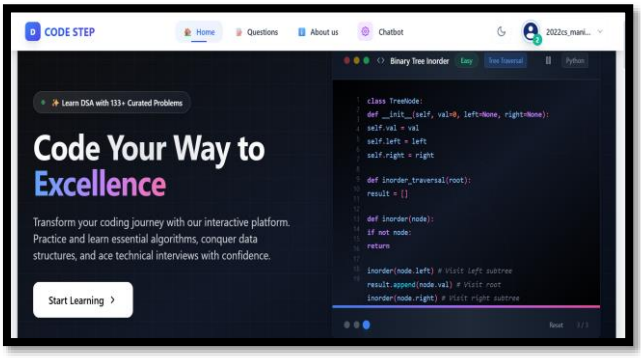

Fig 1. User Interface page

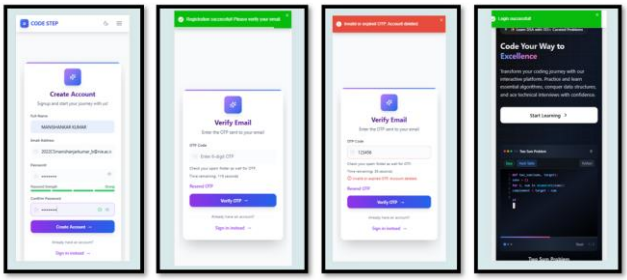

Fig2:-User authentication page

Problem Management Module: The Problem Management Module is the part of this website that shows users all the problems relating to Data Structures and Algorithms (DSA). Users are able to filter and search through problems based on difficulty (Easy, Medium, Hard) and/or topic (e.g. Arrays, Trees, Graphs). All problems are catalogued in a database and can be browsed neatly from this website.

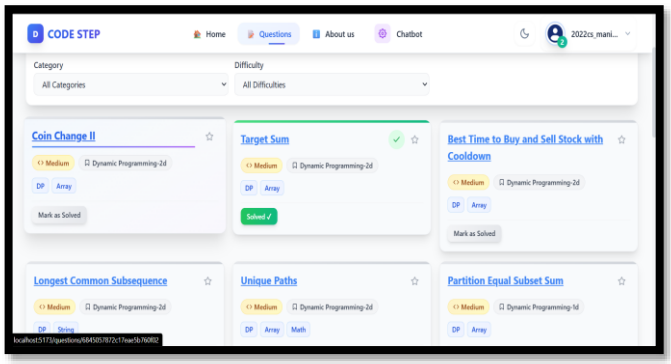

Fig3:- Problem management module

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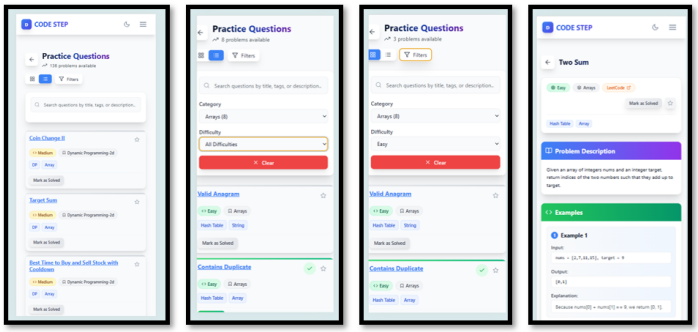

Fig4:- Problem management page

AI Assistant Module: This module gives **real-time help** to students using the **Gemini API** When a user gets stuck, they can ask the chatbot questions in simple language.The AI assistant explains the problem, gives hints, and even helps improve code.It acts like a virtual teacher available anytime.[1][2]

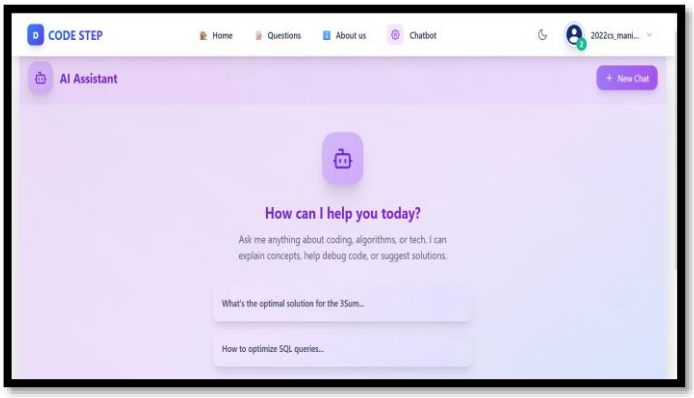

Fig5:- AI assistant page

Fig6:- AI assistant demonstration page

Progress Tracking Module: This module keeps track of how the user is performing. It records how many problems are solved, the accuracy, and the time taken for each topic. The data is shown on a dashboard with graphs and charts to make it easy to understand.[1]

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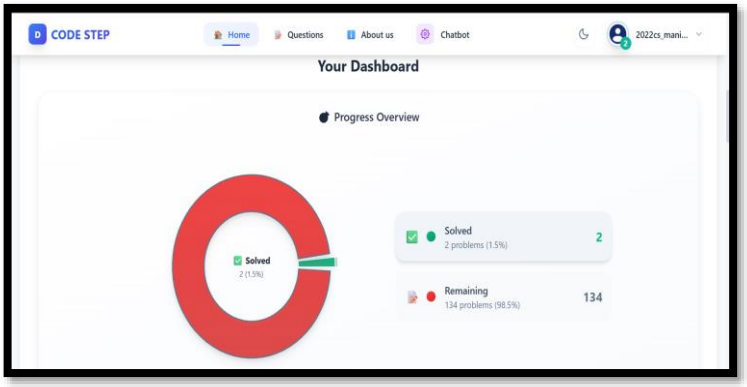

Fig7:- Progress tracking page

User Interface Module: This is the front-end part of the system what the user sees and interacts with. It is designed to be simple, clean, and easy to use. Students can open the website, browse problems, write code in multiple languages (Python,Java, or C++), and chat with the AI assistant. all in one place.[2][3]

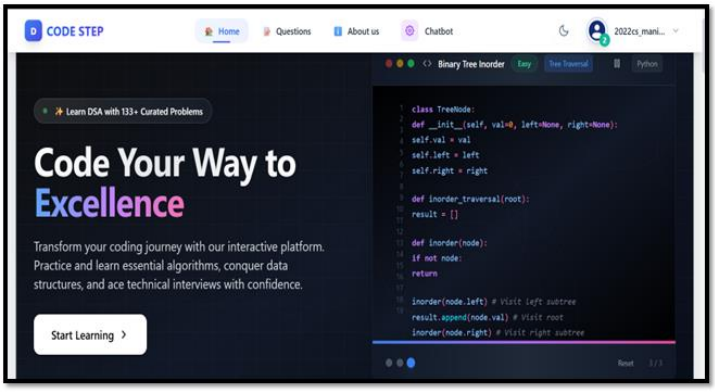

Fig8:- User interface page

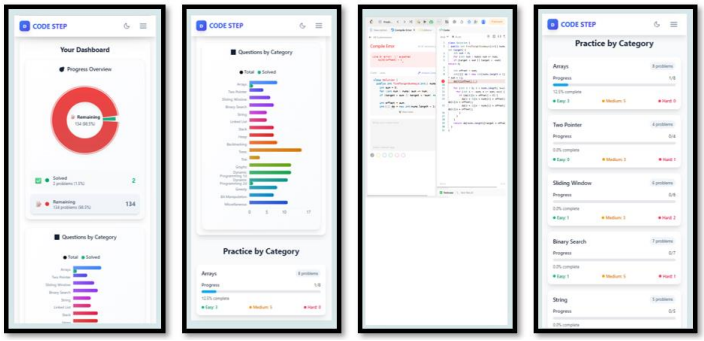

Fig9:- User interface page

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SYSTEM DESIGN AND ANALYSIS

High Level Design

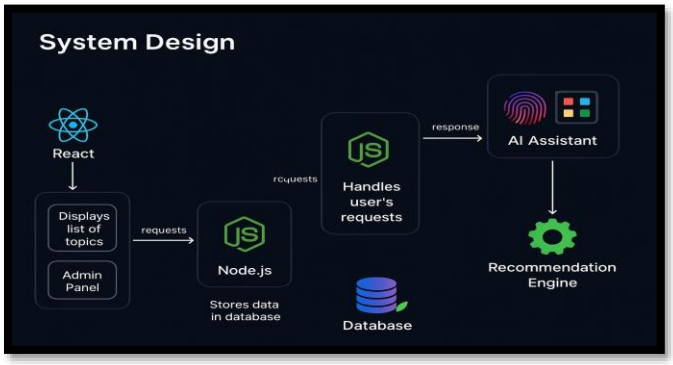

Fig10:- high level diagram

Low Level Design

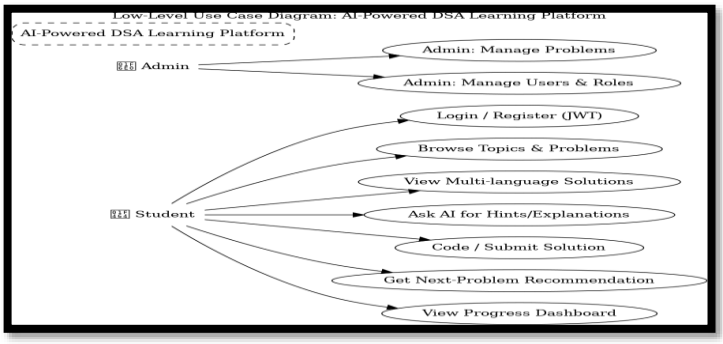

Fig11:- low level diagram

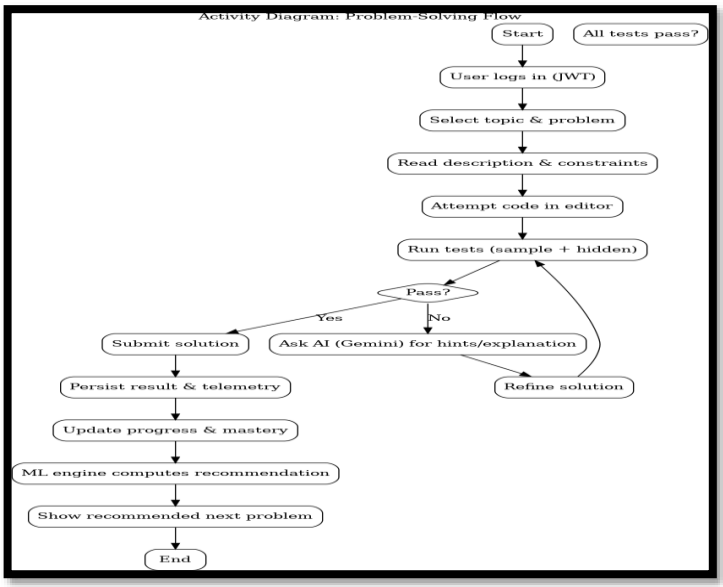

Fig12:- Low level activity diagram

IV. EXISTING SYSTEM

At present, a large number of students are using websites such as LeetCode, HackerRank and GeeksforGeeks as training resources for developing their skills in the areas of Data Structures and Algorithms (DSA), and these types of websites are frequently used by digital technology developers. While these sites offer extensive resources when it comes to

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practicing coding skills, they may not be as beneficial for students who are new to DSA or students who are beginning their study of DSA.[5]
One primary limitation of these types of platforms is that they do not provide a structured learning plan for their users. Users are typically presented with a large volume of coding questions, but there is no indication of which topic they should begin learning about first.

Additionally, the platforms do not cater specifically to the needs of each unique user. Because of this, there are instances where a user may receive questions that are too simple or too difficult for them, which could lead to a decline in a user's confidence or a loss of motivation.[9]

V. PROPOSED SYSTEM

The proposed system, CODE-STEP, is designed to overcome all the problems found in existing learning platforms. It introduces an AI-powered learning environment that focuses on structured guidance and personalized support.

Instead of giving random problem lists, CODE-STEP provides a clear learning path. Students start from simple topics like arrays, loops, and basic logic, and slowly move to more complex topics like dynamic programming, trees, and graphs. This step-by-step approach makes learning smooth and easier to understand.[1]

One of the key features of CODE-STEP is the AI chatbot. This chatbot acts like a virtual teacher who is always available. When students do not understand a problem or concept, they can simply ask the chatbot for help. The chatbot explains the logic in simple words, gives small hints, and even breaks down solutions step-by-step. This reduces confusion and builds confidence.
Students receive personalized feedback and are supported by an AI chatbot that explains concepts clearly. This makes learning more organized, efficient, and less stressful.[2][8]

VI. RESULTS AND ANALYSIS

The CODE-STEP system was tested with a group of users, including beginners and intermediate learners. The testing focused on how well students understood concepts, how confident they felt, and how easily they could solve DSA problems.[4]
The results showed a clear improvement in learning outcomes. Most students said that they understood concepts better because the AI chatbot explained them in a simple and friendly way. They also felt more confident because they received step-by-step guidance instead of being left to figure things out alone.[4][7]

VII. CONCLUSION

CODE-STEP is a simple, smart, and effective learning platform designed to improve the way students learn Data Structures and Algorithms. By using Artificial Intelligence, it provides structured learning, real-time support, and personalized recommendations that match each student's capability.[1]
The platform significantly reduces confusion and frustration commonly faced by beginners. It helps students understand concepts more clearly, develop better problem-solving skills, and gain confidence. Learning becomes more interactive, enjoyable, and less stressful compared to traditional systems.[3][5]

CODE-STEP transforms DSA learning from a difficult task into a guided and supportive experience. Students are not only able to solve problems but also understand the logic behind them, which strengthens their foundation.[2][5]
In the future, the platform can be further improved
by adding features such as:

- Voice-based AI assistance
- Video explanations for concepts
- More programming language support
- Advanced performance analytics.

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