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Educational Data Analytics for Student Report using Big Data Analysis

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ABSTRACT:

In today's data-driven world, educational institutions generate vast amounts of data through online learning platforms, assessments, and student interactions. This project aims to harness that data to gain insights into student performance and **generate personalized academic reports**. Using a MERN stack application integrated with Chart.js, the system **analyzes course popularity, pass rates, average grades**, and other key indicators. The backend leverages **Node.js and MongoDB to process data** sourced from **Google Forms or LMS APIs**, while the frontend presents it using responsive visualizations.

Introduction:

Modern education systems increasingly rely on digital tools to track student performance, participation, and learning behaviors. However, without proper analysis, this data remains underutilized. This project seeks to bridge that gap by developing a data analysis system that processes educational data to produce intuitive, visual reports. The primary objective is to identify factors affecting student performance and improve academic planning through insights drawn from interaction patterns and assessments.

Problem Statement:

Educational institutions lack an integrated, data-driven platform that offers both real-time analysis and report generation to support students and educators.

Literature Review:

Past research in educational data mining (EDM) highlights the potential of data analytics in improving academic outcomes. Systems like Moodle provide raw data, but lack comprehensive analytics. This project fills that gap with a custom-built MERN stack solution, focusing on usability and educational relevance.

A. Exploratory Data Analysis in Schools: A Logic Model to Guide Implementation

- **Matthew Courtney (2021)** : Exploratory data analysis (EDA) is an iterative, open-ended data analysis procedure that allows practitioners to examine data without preconceived notions to advise improvement processes and make informed decisions.
- **Data use within education:** Education systems have been systemically collecting data for both reporting and con-tinuous improvement purposes for many years (Cannata, Redding, & Rubin, 2012; Data Quality Campaign, 2012).
- Link: https://www.researchgate.net/publication/351858121_Exploratory_Data_Analysis_in_Schools_A_Logic_Model_to_Guide_Implementation

B. Study on Exploratory Data Analysis Applied to Education

- **IEEE - Alma Delia Otero-Escobar (2023) :** Data mining has had a wide application in the educational field. This discipline seeks to analyze the data generated in educational environments to improve teaching processes and predict academic performance.
- Link: https://ieeexplore.ieee.org/document/10329702

C. Managing Student's Grades and Attendance Records using Google Forms and Google Spreadsheets -

- **Data Collection Using Google Forms and Sheets:** Using Google sheets and forms to collect students data for analysis.
- Google Form can be used to conduct online quizzes, surveys on teaching effectiveness, collecting answers of open-ended questions and so on. The form can be easily published on the Web through a special url generated by Google.
- To collect student performance data in a structured and scalable way, Google Forms was used as the primary input tool. Educators

can design custom forms to collect data such as quiz scores, attendance, time spent on learning resources, and course feedback.

- Link: https://www.researchgate.net/publication/257716690_Managing_Student's_Grades_and_Attendance_Records_using_Google_Forms_and_Google_Spreadsheets

D. Integration with Google Sheets API

- To automate data extraction and analysis, the system integrates with the Google Sheets API. This API enables the backend (built with Node.js).
- The use of the Google Sheets API ensures that the system can work with live data and does not require downloading and re-uploading spreadsheets manually.
- Link: https://developers.google.com/workspace/sheets/api/guides/concepts

E. Role of Node.js in Backend Development

- Node.js plays a central role in this project as the backend runtime environment responsible for handling data processing, API communication, and database interaction.
- This makes it an ideal choice for real-time educational data analysis systems that require responsiveness and scalability.
- **Data Retrieval Using Google Sheets API -** Node.js integrates with the Google Sheets API to fetch student data directly from the connected spreadsheets. Sends HTTP requests to read dynamically identified ranges
- **API Development** - RESTful APIs are developed using Express.js, a lightweight framework built on Node.js. These APIs allow the frontend (React.js) to request processed data, student records, and downloadable reports. Key endpoints include:
    1. **/api/v1/sheet-data**: Returns aggregated metrics for dashboard visualization
    2. **/api/v1/sheet-data/analyze-sheet**: Sheet data analysis
    3. **/api/v1/sheet-data/quiz-data**: Previous quiz data analysis for pass and fail rates.
- Link: https://medium.com/pipedrive-engineering/maintaining-rest-api-documentation-with-node-js-part-i-65e9700e3b30

Methodology:

This project follows a modular approach to analyzing educational data and generating student reports. The methodology involves four core phases: data collection, data processing and calculation, system integration, and visualization. Each component plays a key role in transforming raw educational data.

1. Data Collection

- The system utilizes Google Forms as the primary interface for collecting data from students. These forms are designed to gather structured information as per needs.
- Once submitted, the form responses are automatically logged into a connected Google Sheet.
- To automate access to the Google Sheet, the system uses the Google Sheets API. The API enables backend scripts to:
- Authenticate securely using OAuth 2.0

2. Data Processing and Calculation

- Once the data is fetched using the Google Sheets API, the backend (built with Node.js) performs several processing tasks.
- Pass/Fail Rate: Percentage of students above or below a defined threshold
- Average Score: Calculated per course and per student
- Course Popularity: Based on student enrollment frequency

3. System Integration

- Integration ensures seamless communication between the components of the system:
- Backend (Node.js + Express)
    1. Handles API requests for data retrieval and processing
    2. Offers secure and RESTful endpoints to the frontend
    3. Uses Google Sheets API to fetch real-time data
- Frontend (React.js)
    1. Fetches processed data via backend APIs
    2. Renders the dashboard using Chart.js to display:
    3. Doughnut charts for pass/fail distribution
    4. Stacked bar charts for course-wise scores
- Provides form input for uploading new datasets

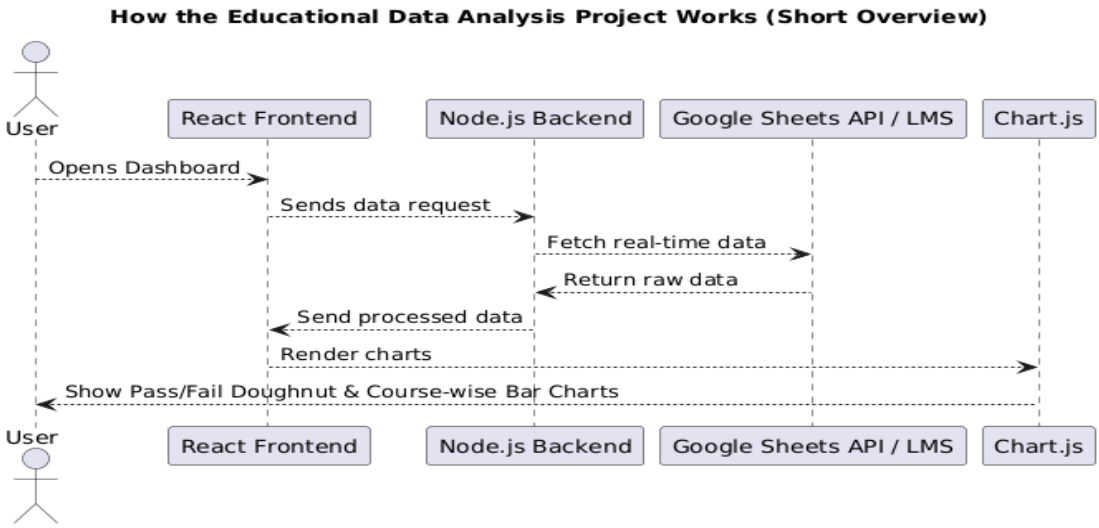

Fig. 1 Educational data analysis project works in short

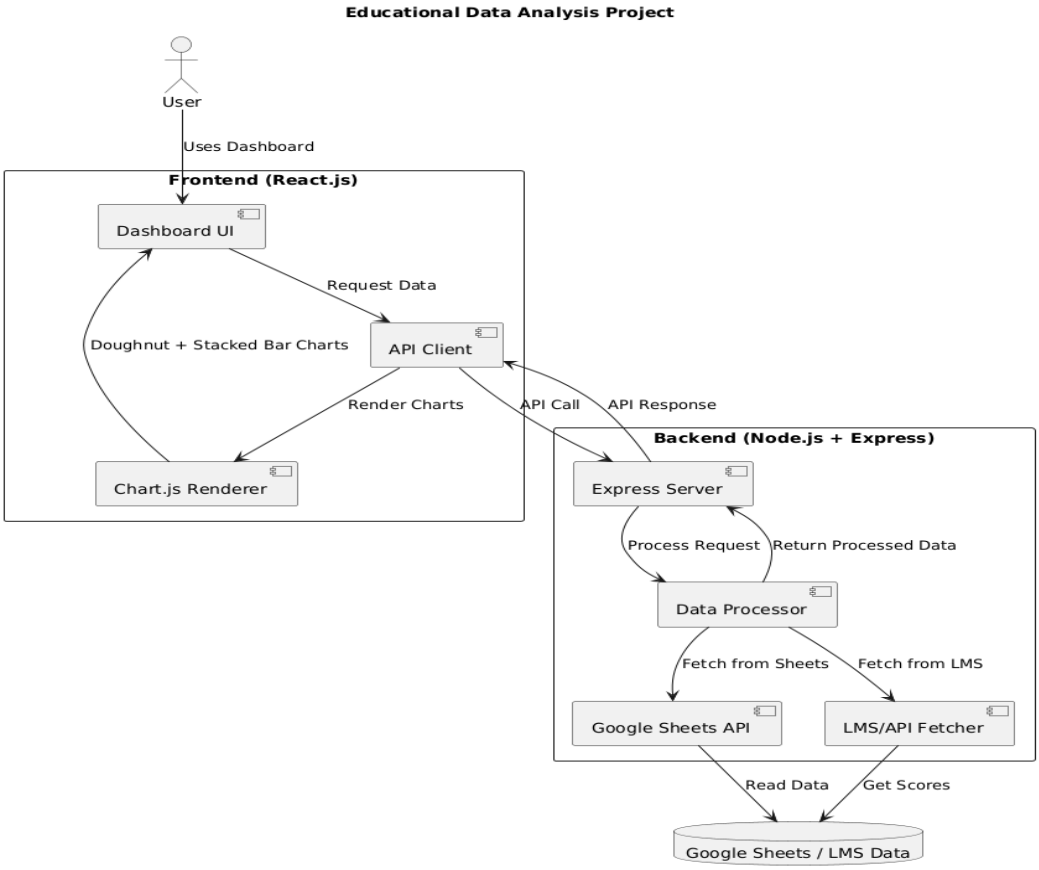

Fig.2 Flow diagram of frontend and backend of project

Results and Analysis:

Visuals include Doughnut charts for *most popular course* distribution and stacked bar graphs for *subject-wise scores.*

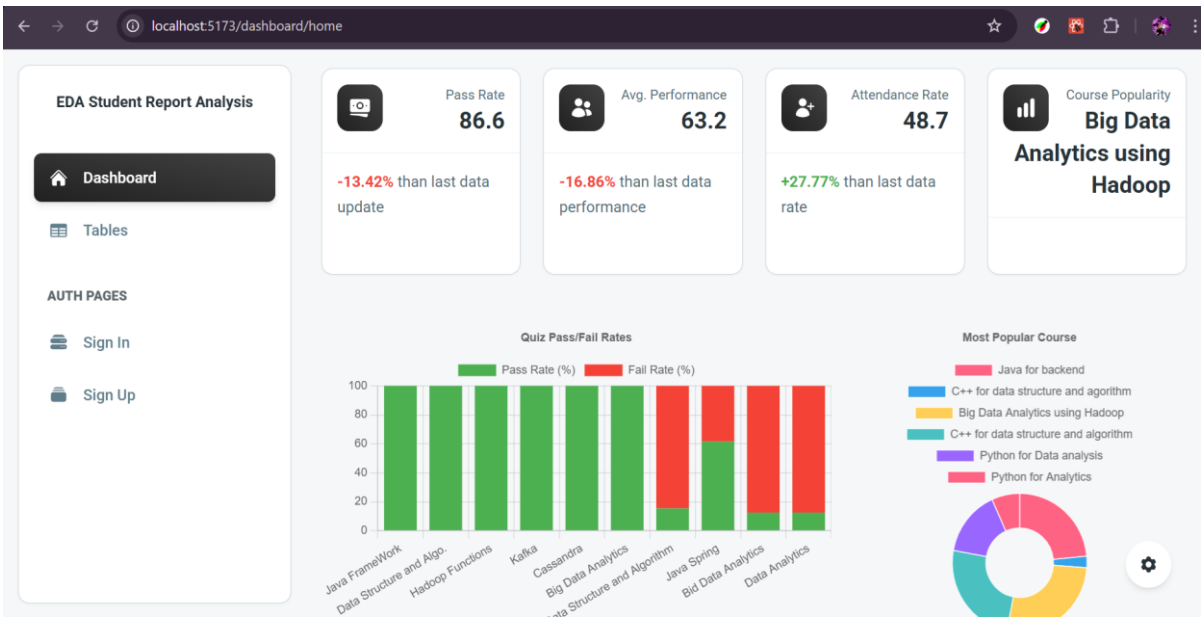

Fig. 3 Dashboard and analysis of educational data in sheet

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Conclusion:

This project demonstrates how integrating modern web technologies with real-time data sources can significantly enhance educational data analysis and student performance reporting. By leveraging tools such as Google Forms, Google Sheets, and the Google Sheets API, the system provides a seamless and automated method for collecting and managing student-related data.

The use of Node.js for backend processing ensures that data is efficiently fetched, cleaned, and transformed into meaningful insights, while MongoDB provides scalable storage for analytical metrics. The React.js frontend, supported by Chart.js, offers a dynamic and interactive dashboard that enables educators to visually interpret key performance indicators such as pass rates, course popularity, and average scores.

Overall, this project bridges the gap between raw educational data and actionable feedback, empowering teachers and institutions to make informed interventions. The framework is highly adaptable and can be extended to include predictive analytics, personalized recommendations, and integration with Learning Management Systems (LMS) in future enhancements.

Future Work:

- Add predictive analytics to forecast student risk of failure
- Integrate with real-time LMS platforms (e.g., Moodle, Google Classroom)
- Enhance reports with AI-driven course recommendations
- Implement secure authentication for different user roles (Admin, Teacher, Student)

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