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AI-Powered Student Dropout Prediction and Intervention System Using Gemini AI and Supabase Integration

Mohammed Zaid Ejaj Pathan[1], Bharadwaj Premising Patil[2], Om Ganesh Devkar[3], Prof. Nilesh S. Ahire[4]
Department of Artificial Intelligence and Data Science, MET Institute of Engineering Nashik, Maharashtra

Abstract: ***This project presents a web-based intelligent system designed to predict potential student dropouts using Artificial Intelligence (AI) and provide automated, personalized counselling to at-risk students. The proposed model integrates predictive analytics, real-time data processing, and generative AI-based de- cision support. The system architecture combines a React-based frontend, Supabase backend, and Gemini AI agent for natural language interaction and adaptive feedback. It analyzes both academic (attendance, grades, performance) and non-academic parameters (engagement, sentiment, socio-economic context) to calculate dropout risk scores and suggest tailored interventions. By combining AI prediction with human feedback loops, the system empowers educators to identify, understand, and assist students before disengagement occurs, significantly improving student retention and academic success rates.***

Index Terms: Student Dropout Prediction, Predictive An- alytics, Supabase, Gemini AI, ReactJS, Academic Retention, Generative AI, Data-Driven Counselling

I. INTRODUCTION

The issue of student dropout continues to be a critical challenge in educational institutions worldwide. According to UNESCO (2022), over 35% of undergraduate students fail to complete their programs, primarily due to academic stress, lack of motivation, or socio-economic constraints. Traditional academic tracking systems are reactive, identifying issues only after performance declines significantly.

Recent advancements in machine learning (ML) and ar- tificial intelligence (AI) have enabled predictive approaches to student management. Predictive models can process large datasets of student behavior, grades, attendance, and engage- ment patterns to forecast the probability of dropout. However, the majority of existing systems lack the ability to offer personalized counselling or adaptive academic planning.

This research proposes an AI-powered system that com- bines predictive analytics with a conversational AI layer to recommend actionable interventions. Using Gemini AI (Google's multimodal generative model) integrated within a Supabase-React ecosystem, the system provides real-time academic monitoring and adaptive guidance to both students and teachers. Teachers can record reviews, assign customized tasks, and collaboratively track progress through the intelligent dashboard.

II. LITERATURE SURVEY

Several studies have explored data-driven dropout predic- tion; however, few integrate real-time analytics with personal- ized AI-based feedback.

A. Predictive Approaches in Education

Nguyen et al. (2021) applied logistic regression and neural networks for dropout prediction in Massive Open Online Courses (MOOCs), achieving 85% accuracy using attendance and quiz data. Kumar and Gupta (2022) employed Random Forest models on institutional datasets, demonstrating that engagement metrics were stronger dropout indicators than grades.

B. AI-driven Counselling Systems

Li et al. (2023) explored the use of chat-based AI systems to provide academic support through personalized conversa- tion. However, their system lacked integration with real-time student analytics. Patil et al. (2024) introduced a Supabase- integrated student tracking system for Indian universities but did not include automated decision generation.

C. Gap Identification

From these studies, it is clear that:

1) Existing systems emphasize prediction accuracy over actionable support.
2) Real-time feedback and conversational interfaces are rarely implemented.
3) Few systems integrate structured (grades, attendance) and unstructured (reviews, emotion analysis) data.

Therefore, there exists a research gap in creating an in- tegrated, AI-based, and conversationally interactive dropout prevention framework.

III. RESEARCH GAP

Current educational analytics systems rely mainly on static datasets and batch predictions. There is little focus on real- time analysis or the psychological and behavioral dimensions influencing student retention. Moreover, counsellor workloads often delay responses to early warning signs, causing pre- ventable dropouts.

Another challenge is the lack of integration between an- alytics and institutional management tools. Most systems provide dashboards but lack proactive recommendation en- gines. Furthermore, emotional data (e.g., feedback tone, survey sentiment) is rarely quantified.

The proposed model bridges these limitations by introduc- ing:

1) AI-powered early warning system for dropout risk.
2) Gemini AI-based counselling engine for adaptive feed- back.
3) Dynamic React dashboard and Supabase backend for real-time tracking.

IV. PROBLEM STATEMENT

Despite technological progress, academic institutions still struggle with identifying and assisting at-risk students in time. Manual methods are inconsistent, and existing predictive tools are non-interactive and data-siloed.

1) Problem Definition: Develop an AI-based intelligent web system capable of predicting student dropouts using multi-dimensional academic and behavioral data, while generating personalized counselling plans and performance improvement suggestions.
2) Research Questions:
a) How can AI improve the accuracy of dropout prediction in dynamic educational environments?
b) How can conversational AI systems like Gemini provide personalized academic counselling at scale?
c) How can real-time data from Supabase and React dash- boards be utilized for adaptive interventions?

V. OBJECTIVES

The proposed study aims to achieve the following objectives:

1) To design and implement an AI-based predictive model that classifies students by dropout risk level.
2) To integrate real-time academic data pipelines using Supabase.
3) To incorporate Gemini AI for generating personalized counselling and intervention strategies.
4) To provide teachers with an interactive dashboard to monitor student performance.
5) To reduce dropout rates through proactive and data-driven engagement.
6) Faculty feedback: qualitative comments and assessment reports.

Data is stored in Supabase, enabling real-time updates and synchronization across dashboards.

A. Preprocessing and Feature Engineering

Data is cleaned, normalized, and encoded. Missing values are imputed, and categorical variables are transformed using one-hot encoding. Sentiment analysis on feedback and surveys is performed using Gemini AI's text interpretation API to convert qualitative responses into numerical features.

B. Model Training

Supervised learning algorithms such as Random Forest, XGBoost, and Logistic Regression are trained on historical student datasets. The model outputs a *Dropout Probability Score (DPS)* between 0 and 1, indicating the likelihood of student disengagement.

C. *Prediction and Classification*

Based on the DPS value, students are categorized as:

1) Low-risk ($0.0 \leq DPS < 0.4$)
2) Moderate-risk ($0.4 \leq DPS < 0.7$)
3) High-risk ($0.7 \leq DPS \leq 1.0$)

These thresholds trigger automated AI counselling through the Gemini API.

D. *AI Integration and Feedback Generation*

The Gemini AI agent analyzes the student's risk profile and generates a personalized action plan, including:

1) Suggested study schedules or peer group recommenda- tions.
2) Motivational or psychological counselling dialogues.
3) Teacher notifications for manual follow-up.

All feedback is logged in the teacher dashboard for trans- parency and further review.

VI. METHODOLOGY

The system methodology involves five stages as depicted in Fig. 1. It combines machine learning, natural language processing (NLP), and web integration.

A. *Data Collection*

Data sources include:

1) Academic performance: grades, attendance, assignments.
2) Behavioral factors: login frequency, participation, feed- back tone.
3) Socio-economic data: parental income, scholarship status.

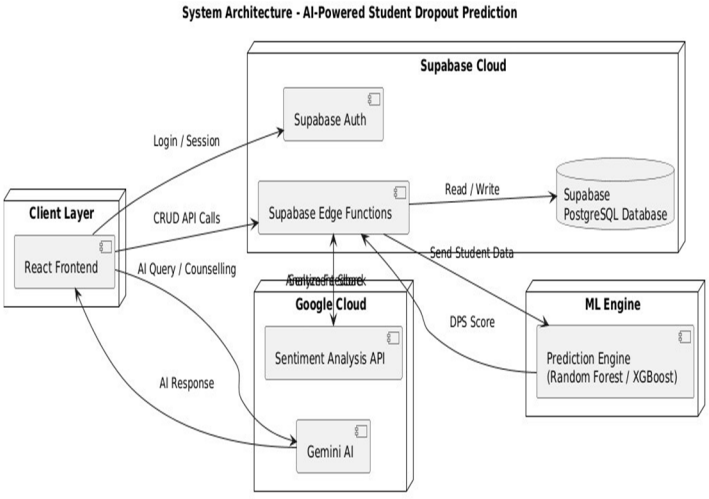


Fig. 1. Proposed Methodology and Data Flow for Dropout Prediction and AI Intervention System.

VII. PROPOSED FRAMEWORK

The architecture of the AI-powered dropout prediction sys- tem is designed around three major layers: data, intelligence, and interface, as shown in Fig. 2.

A. *Data Layer*

This layer consists of Supabase databases that store aca- demic, behavioral, and socio-economic data. It supports real- time updates via WebSocket connections for seamless React integration.

B. Intelligence Layer

This layer includes:

1) Predictive Model: Generates dropout probability based on academic and behavioral data.
2) AI Reasoning Module: Gemini AI interprets predictions and formulates human-like counselling responses.
3) Feedback Engine: Prioritizes intervention strategies ac- cording to risk levels.

C. Interface Layer

The user-facing React dashboard provides:

1) Student analytics with progress visualization.
2) Teacher notes, feedback logging, and custom plan cre- ation.
3) Chat interface for AI-based student interaction and sup- port.

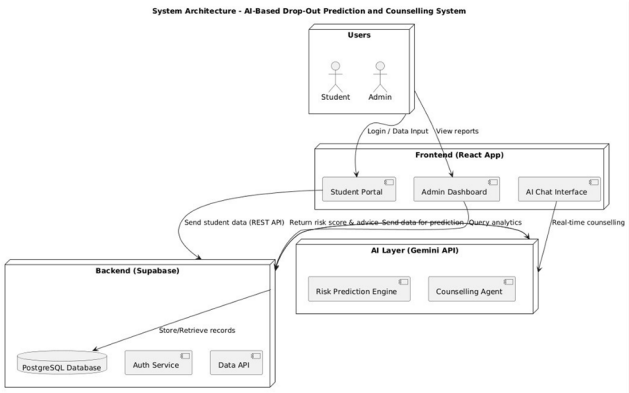
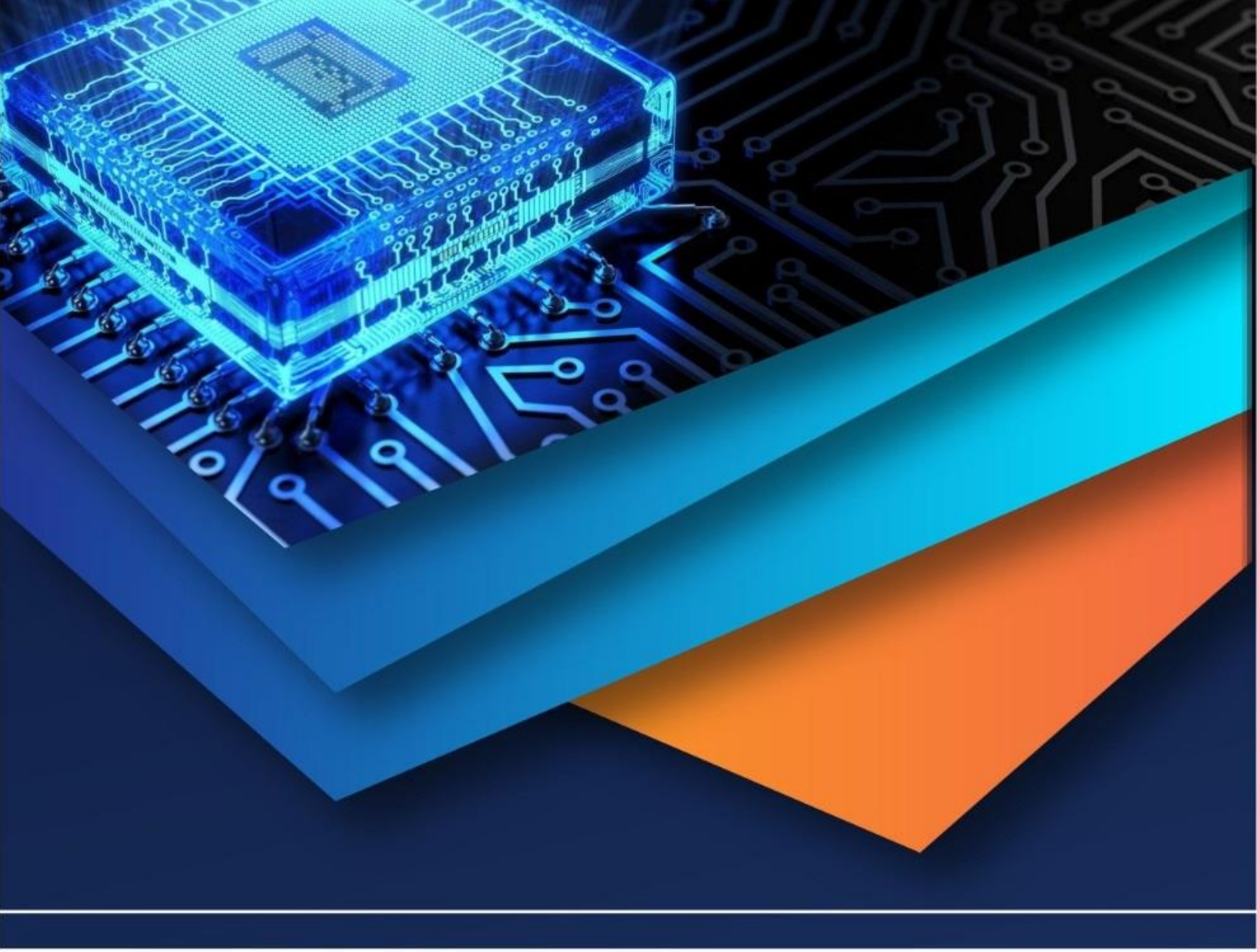


Fig. 2. Proposed Framework Architecture for AI-Powered Dropout Prediction and Intervention.

This framework facilitates a continuous feedback loop where student performance triggers AI analysis, which in turn generates counselling actions and updates institutional dashboards in real time.



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