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Implement Software Solutions to Reduce Student Dropout Rates at Various Educational Stages

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ABSTRACT: Student dropout rates in India are influenced by socio-economic and educational factors, particularly affecting marginalized communities. The **National Education Policy (NEP) 2020** emphasizes reducing dropout rates and ensuring quality education up to the secondary level. To address this, innovative software solutions are proposed. **AI-Driven Early Warning System** – Uses AI to analyze student data (attendance, grades, behavior) and predict at-risk students. It provides **real-time alerts**, **predictive analytics**, and **intervention recommendations**. **Community Learning Hub Platform** – An online platform offering **digital resources**, **virtual mentoring**, and **tutoring sessions** to support students in resource-limited rural areas. **Financial Support Management System** – Manages **scholarship applications**, **disbursement tracking**, and **eligibility assessment** to reduce economic barriers. **Flexible Schooling Management System** – Allows students to enroll in **evening or part-time programs**, manage schedules, and track academic progress with **dynamic scheduling** and **data synchronization**. **Student Support and Engagement System** – Provides **counseling resources**, **motivational content**, **goal-setting tools**, and **engagement tracking** to support at-risk students. By leveraging technology, these solutions align with **NEP 2020** goals to improve student retention and ensure **universal access to education**.

KEYWORDS: Student Dropout, Early Warning System, AI Prediction, Predictive Analytic, Intervention Strategies, National Education Policy 2020 (NEP 2020), Education Technology, Real-time Alerts, Community Learning

I. INTRODUCTION

Education is a powerful tool for shaping the present and future of an individual and society at large. In India, however, dropout rates amongst learners of a marginalised community and section in society remains an impediment. There are a host of educational and socio-economic reasons like financial aid, lack of proper infrastructure and poor access to quality education which compound this issue. In order to facilitate holistic socio-economic development and foster equitable systems, addressing dropout rates is critical.

The **National Education Policy (NEP) 2020** underscores the need to lower drop out levels and aim to provide education of a reasonable standard till at least the secondary level. To from computerized solutions to this problem, technology can be leveraged to identify community at risk dropouts to provide necessitated support in a positive manner.

This paper deals with the problem of educating students who dropout of school by devising **highly innovative software solutions**. These consist of an **AI powered early warning system** for predicting prospective at-risk students who may drop out, a **community learning-hub based platform** where volunteer mentors can provide digital resources, a **grant management system** with an automated workflow for scholarships award applications, a **management system for flexible schooling** that enables parents to teach their children at home, and a **student support and engagement system** that motivates by providing guidance and counseling.

The goal of these strategies is to construct a self-sufficient solution to student retention using technology while also furthering the goal of universal access to education as envisioned in NEP 2020.

Paper is organized as follows. Section II describes automatic text detection using morphological operations, connected component analysis and set of selection or rejection criteria. The flow diagram represents the step of the algorithm. After detection of text, how text region is filled using an inpainting technique that is given in Section III. Section IV presents experimental results showing results of images tested. Finally, Section V presents conclusion.

II. LITERATURE SURVEY

The dropout issue remains a noteworthy one, especially for developing nations such as India. A number of studies have attempted to explain the dropout phenomenon and formulate some technological remedy towards the problem. This literature review contains the most important findings related to dropout forecasting, intervention measures, and technology aids developed from prior research with focus on automation and education.

Reasons students drop out of school: **Rumberger & Lim (2008):** identified student's socio-economic status, parental education levels, and school facilities as major determinants of student dropouts. Indian studies like **Govinda & Bandyopadhyay (2011)** indicate that financial issues, social discrimination, and deficient economic infrastructure are significant factors explaining the high dropout levels in rural regions.

Systems for predicting dropouts based on Artificial Intelligence: There has been considerable research activity applying machine learning (ML) and artificial intelligence (AI) to the prediction of student dropouts. **Kotsiantis et al. (2003)** designed an inhouse system that provides early warning of potential dropouts based on attendance and performance through the application of decisions trees and regression techniques. More recent research like **Ahmed et al. (2020)** focuses on using new approaches like deep learning and neural networks to enhance efficiency in dropout prediction.

Collaborative Learning and Social Media Platforms: The influence of software programs and the internet in curbing educational discontinuity has been closely researched in the literature. **Perraton (2000)** looked at the ways in which distance education offers learning opportunity for students based in the far regions. **Mishra & Sharma (2018)** examined community-based learning centers and found that the availability of digital materials, instruction, and guidance services increase retention levels.

Financial Assistance Services and Their Administration: Financial issues rank among the top reasons for students not completing their studies, thus aid funds are imperative. **Banerjee & Duflo (2011)** proved that cash payment programs and scholarships have a positive effect on retention, particularly for those students who are at risk.

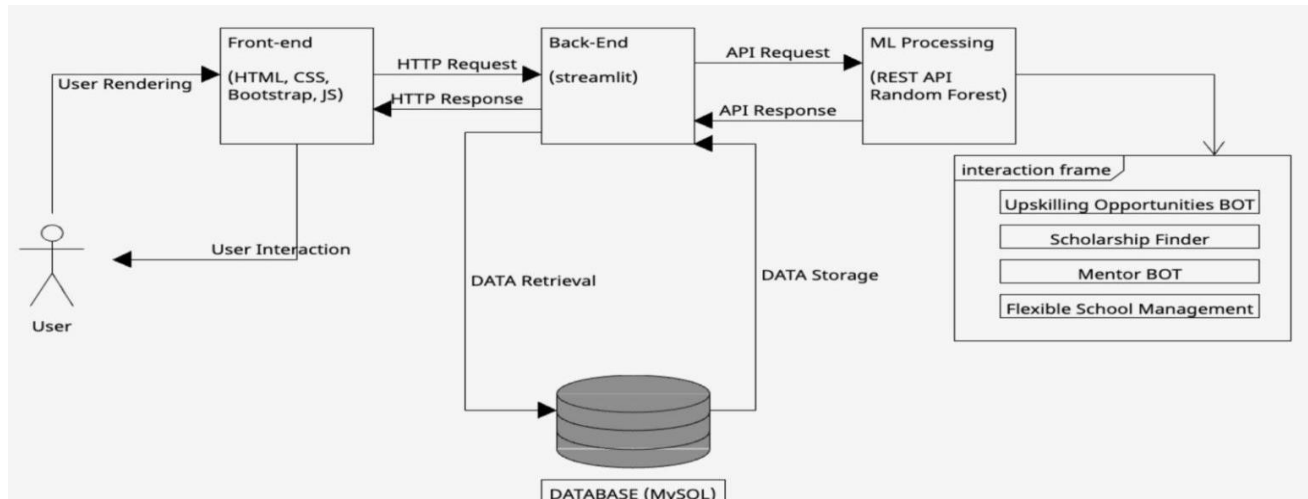
Chakrabarti et al. (2019) developed a system of online scholarship management to eliminate manual processing to enhance accountability, which corresponds with the proposed Financial Support Management System in this study.

Blended Learning and Other Forms of Schooling: Research pertaining to more flexible forms of schooling suggest that these are evening schools and other forms of part-time education for those learners who have difficulties attending full-time classes. **De Moura et al. (2014)** shows that students learn better when they use blended teaching methods that mix face-to-face and online teaching.

III. PROPOSED SYSTEM

The suggested system utilizes Random Forest with Gradient Boosting for predicting dropout and a Streamlit web application for real-time insights and interventions. The suggested system is intended to identify in advance students at risk of dropping out and apply targeted support measures to alleviate dropout rates. By combining predictive analytics, auto-alerts, financial aid support tracking, and social networking, the system achieves a comprehensive strategy for

student retention. This solution is flexible, scalable, and configurable to different types of institutions so that schools and policy makers can use data to drive decisions. The AI-based model learns from new student data in real-time, refining its accuracy over time. The system also provides collaboration among educators, parents, and counselors so that students can get timely intervention and support. With alignment of the **National Education Policy (NEP) 2020**, this software solution increases educational access and supports long-term academic success.



Architectural Diagram

IV. METHODOLOGY

The methodology adopts a formal approach, with Random Forest with Gradient Boosting for dropout prediction and a Streamlit-based web application for real-time monitoring and intervention. The design and deployment of the AI-based Student Dropout Prediction and Intervention System are based on a systematic approach that combines machine learning, real-time analytics, and collaborative efforts with stakeholders. The methodology is divided into the following major phases:

1. Data Collection and Preprocessing

Data Sources: The framework collects student historical and real-time data from institutional databases, learning management systems (LMS), attendance, academic performance reports, socio-economic indicators, and engagement.

Data Cleaning: Missing values are treated with imputation methods, outliers are identified and addressed, and categorical variables are encoded.

Normalization & Standardization: Numerical features are normalized to make them consistent for model training.

2. Predictive Model Development

Algorithm Selection: The system utilizes a Random Forest model with Gradient Boosting for high accuracy and stability.

Model Training: Preparing the dataset into training and testing sets with cross-validation for the hyperparameter optimization.

Evaluation Metrics: The performance of the model is evaluated with accuracy, precision, recall, F1-score, and AUC-ROC to guarantee reliable predictions.

3. Integration with Streamlit Web Application

Model Deployment: The trained machine learning model is deployed in a streamlit-based web application for real-time dropout prediction.

User Interface (UI): The app features a user-friendly dashboard that presents risk scores, student trends, and actionable advice.

Table 1: Model performance comparison

MODEL	PRECISION	RECALL	F1SCORE	ACCURACY
Random Forest	0.80	0.74	0.77	0.738
Gradient Boosting	0.84	0.76	0.80	0.761
XGBoost	0.80	0.74	0.77	0.767

User-Friendly Dashboard for Student Drop Out Prediction:

A well-crafted **Streamlit-based** dashboard improves usability through a clean, interactive, and user-friendly interface for educators, administrators, and policymakers. The dashboard presents real-time dropout predictions, student insights, and intervention recommendations in a organized form.

Student Dropout Prediction Using Random Forest with Gradient Boosting

Once student data is collected, it undergoes preprocessing and predictive analysis using **Random Forest with Gradient Boosting** to assess dropout risk. The model leverages multiple student attributes, including academic performance, attendance, socio-economic background, and behavioral factors, to provide an accurate risk assessment.

Steps Involved:**1. Data Preprocessing:**

Handle missing values by applying **mean/median imputation**. Normalize numerical features using:

$$\bullet \quad x' = (x - \mu) / \sigma$$

Where:

- x = Raw feature value
- μ = Mean of the feature
- σ = Standard deviation of the feature

Encode categorical variables (e.g., parental education, financial status) using **one-hot encoding**. Split the dataset into **training (80%) and testing (20%) sets** for model evaluation.

2. Feature Extraction:

Select key features contributing to dropout risk:

- **Attendance rate**
- **GPA and academic performance trends**
- **Parental education level**
- **Socio-economic background**
- **Student engagement in extracurricular activities**

The processed data is passed through the **Random Forest with Gradient Boosting model** to generate a dropout risk score:

$$\bullet \quad f(X) \in [0, 1]$$

where **$f(X)$ = dropout probability score** (0 = Low Risk, 1 = High Risk).

3. Dropout Risk Prediction Using Probability Thresholding

The model predicts whether a student is at risk of dropping out based on a threshold probability (e.g., **0.5**). The dropout classification is determined as follows:

$$P_{dropout} = \begin{cases} \text{Dropout Risk: High,} & \text{if } P \geq 0.5 \\ \text{Dropout Risk: Low,} & \text{if } P < 0.5 \end{cases}$$

The system then **triggers alerts** for high-risk students and recommends **intervention strategies** such as counseling, tutoring, and financial aid.

AI Scholarship Advisor – Smart Scholarship Suggestion System:

The AI Scholarship Advisor is a fill-in-the-blank recommendation platform that assists students in identifying appropriate scholarships according to their academic achievement, financial situation, and qualification criteria. It applies machine learning algorithms to connect students with the most appropriate scholarship opportunities.

Results for AI Scholarship Advisor:

After the student submits their information, the AI Scholarship Advisor runs it through the Hugging Face API and comes up with a personalized list of available scholarships. The system considers performance, financial standing, course of study, and extracurricular activities when searching for the most suitable opportunities.

Scholarship Ranking & Matching using Hugging Face API:

- The system sends student details (e.g., **GPA, income level, field of study, achievements**) to the **Hugging Face API**.
- The API analyzes both **student data** and **scholarship descriptions** to find the best matches.
- The model returns a **ranked list of scholarships** with relevance scores.
- The similarity between the student profile and scholarship requirements is calculated using

$$\text{Cosine similarity}(A, B) = \frac{A \cdot B}{\|A\| \|B\|}$$

- A,B = Feature vectors of student data and scholarship eligibility criteria.
- A similarity threshold (e.g., **0.75**) determines strong matches.

The top scholarships with the **highest similarity scores** are displayed.

Upskilling Opportunities:

Once the model forecasts whether a student is likely to drop out, the system prescribes upskilling opportunities for them based on their field of study and academic credits (low, medium, high). The suggestions intend to enhance students' skills, fill knowledge gaps, and equip them with better chances of academic success.

1. **For low-credit students:** The system recommends core courses, remedial courses, and mentorship assistance to enhance core knowledge.
2. **For students with medium academic credits:** The program of skill development, certification courses, and practical workshops is suggested to enhance academic performance.
3. **For students with medium academic credits:** The program of skill development, certification courses, and practical workshops is suggested to enhance academic performance.
4. **For top-performing students:** Specialization courses at higher levels programs are recommended to enhance career potential.

By combining these targeted interventions, the system not only foretells dropout danger but also gives practical suggestions to guide students towards remaining on course and achieving academically.

Student Motivation Bot:

In order to minimize dropout rates, the system offers personalized support and engagement to at-risk students. It has important features including counseling support, motivational content, and academic goal-setting tools to improve student retention.

1. Counseling Support: Professional counseling, mental health support, and academic advising to enable students to overcome difficulties.

2. Inspirational Content: Motivational success stories, self-improvement tips, and custom encouragement to increase student confidence.

3. Goal-Setting Functionality: Academic goal-setting tools, tracking progress, and reminders to keep students on track. Monitoring Student Engagement: Tracking student participation, detecting disengagement trends, and timely interventions.

Flexible School Management:

The Flexible Schooling Management System helps students enroll for evening or part-time courses, track their schedules, and monitor educational progress effectively.

It features the following major specifications:

1. Enrollment Management: Facilitates students enrolling for flexible learning courses based on their preference.

2. Dynamic Schedule Tracking: Offers continuous updates on lesson schedules, due dates for assignment, and date of exams.

3. Progress Monitoring: Monitors academic performance, attendance, and course completion status.

4. Seamless Integration: Integrate with current school management systems for easy data synchronization.

5. User Role Management: Has multiple roles, such as students, instructors, and administrators, to provide organized access.

6. Scalability and Security: Provides secure data management while being scalable to meet various institutional requirements.

Dashboard of Flexible Student Management:

The Dropout Management System Dashboard is a user-friendly interface for tracking and handling student participation and scholarly activities. The dashboard contains the following essential features:

1. User Overview: Presents the number of students, instructors, parents, and classes to ensure effective tracking of school attendance.

2. Navigation Panel: Grants access to essential modules like Teachers, Students, Parents, Classes, Attendance, Events, Notifications, and Transport for effortless handling.

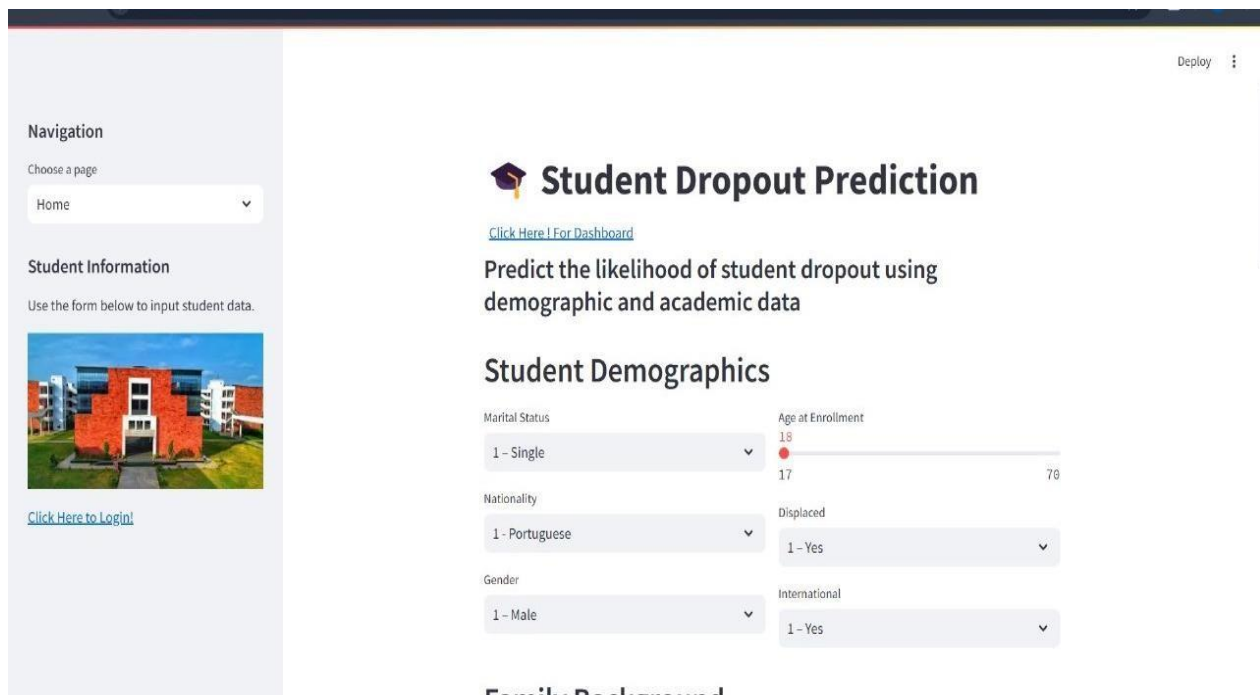
3. Activity Calendar: Identifies forthcoming events, exams, and holidays, allowing for enhanced planning and organization.

4. Examination Section: Offers notifications about planned exams, keeping students prepared.

5. General Settings: Enables administrators to set system preferences and manage user roles.

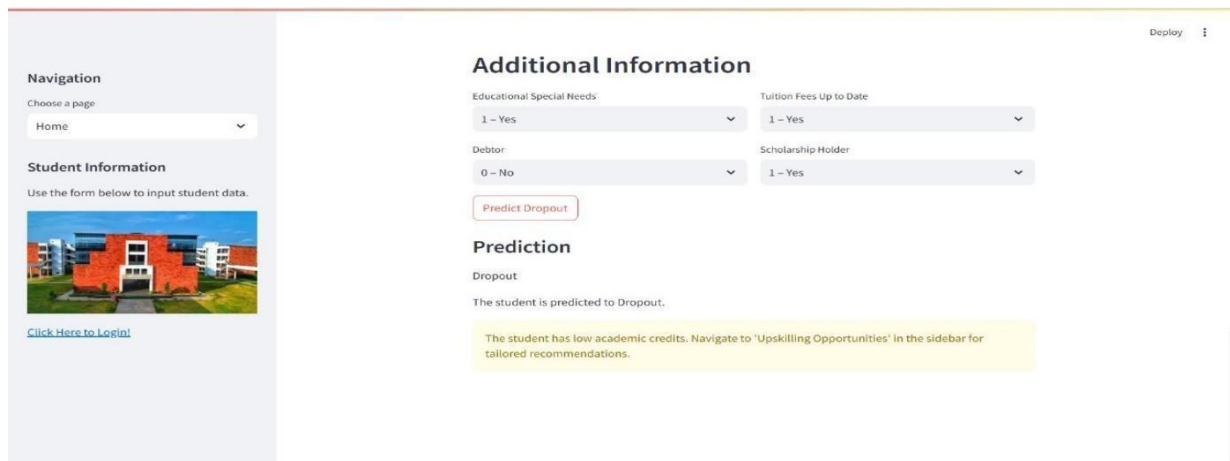
This system provides real-time monitoring, effective communication, and data-driven decision-making to decrease dropout rates and improve student retention.

V. EXPERIMENTAL RESULTS



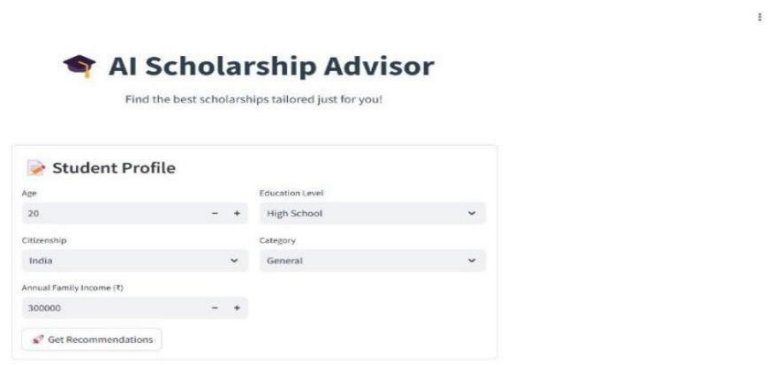
The screenshot displays the 'Student Dropout Prediction' dashboard. On the left is a navigation sidebar with a 'Home' button and a 'Student Information' section containing a login link. The main content area features a title 'Student Dropout Prediction' with a subtitle 'Predict the likelihood of student dropout using demographic and academic data'. Below this is a 'Student Demographics' section with input fields for Marital Status (Single), Age at Enrollment (18), Nationality (Portuguese), Displaced (Yes), Gender (Male), and International (Yes). A 'Family Background' section is partially visible at the bottom.

Fig(1): User-Friendly Dashboard for Student Drop Out Prediction



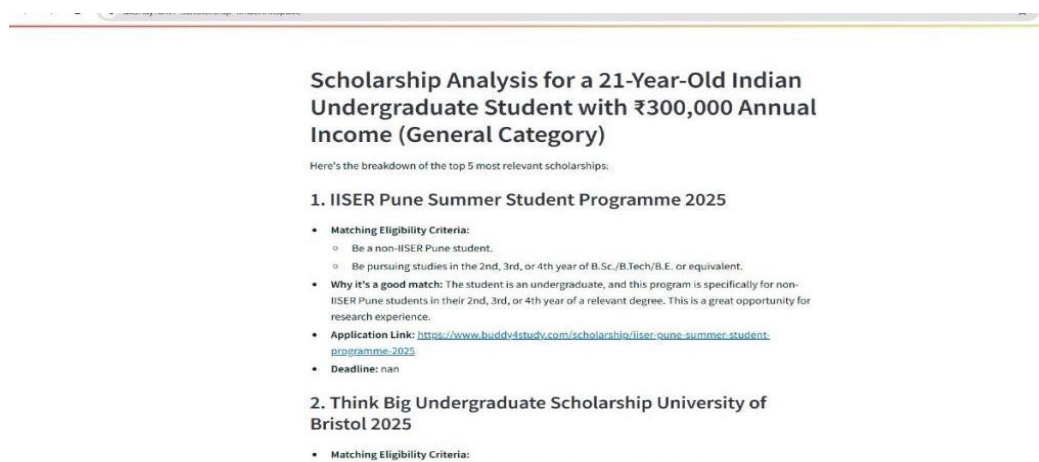
The screenshot shows a web application for Dropout Risk Prediction. On the left is a sidebar with 'Navigation' (Home) and 'Student Information' (a form to input student data and a 'Click Here to Login!' link). The main area is titled 'Additional Information' and contains four dropdown menus: 'Educational Special Needs' (1 - Yes), 'Tuition Fees Up to Date' (1 - Yes), 'Debtor' (0 - No), and 'Scholarship Holder' (1 - Yes). Below these is a 'Predict Dropout' button. The 'Prediction' section shows the result: 'Dropout' and 'The student is predicted to Dropout.' A yellow box contains a recommendation: 'The student has low academic credits. Navigate to 'Upskilling Opportunities' in the sidebar for tailored recommendations.'

Fig(2):Dropout Risk Prediction Using Probability Thresholding



The screenshot shows the 'AI Scholarship Advisor' web application. It has a header with a graduation cap icon and the title 'AI Scholarship Advisor' with the tagline 'Find the best scholarships tailored just for you!'. Below is a 'Student Profile' form with fields for Age (20), Education Level (High School), Citizenship (India), Category (General), and Annual Family Income (₹) (300000). A 'Get Recommendations' button is at the bottom.

FIG(3):AI SCHOLARSHIP ADVISOR

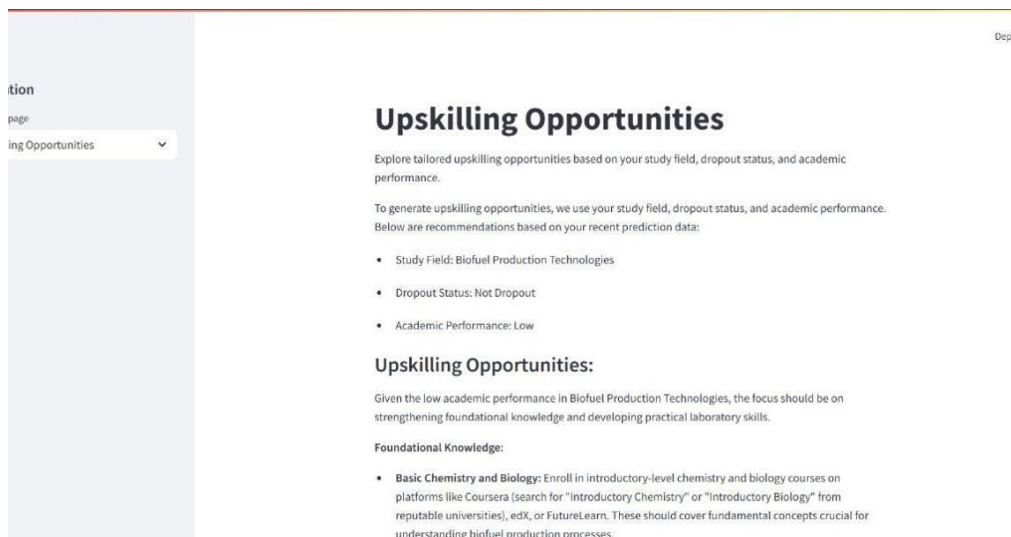


Scholarship Analysis for a 21-Year-Old Indian Undergraduate Student with ₹300,000 Annual Income (General Category)

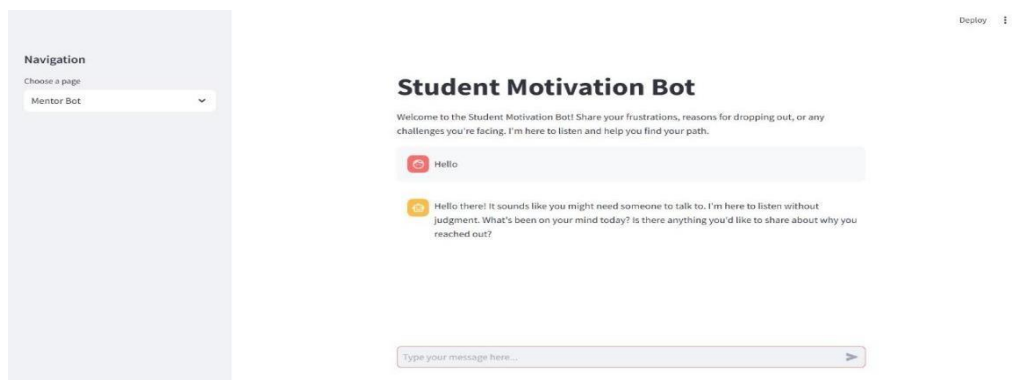
Here's the breakdown of the top 5 most relevant scholarships:

- IISER Pune Summer Student Programme 2025**
 - Matching Eligibility Criteria:**
 - Be a non-IISER Pune student.
 - Be pursuing studies in the 2nd, 3rd, or 4th year of B.Sc./B.Tech/B.E. or equivalent.
 - Why it's a good match:** The student is an undergraduate, and this program is specifically for non-IISER Pune students in their 2nd, 3rd, or 4th year of a relevant degree. This is a great opportunity for research experience.
 - Application Link:** <https://www.buddy4study.com/scholarship/iiser-pune-summer-student-programme-2025>
 - Deadline:** nan
- Think Big Undergraduate Scholarship University of Bristol 2025**
 - Matching Eligibility Criteria:**

FIG(4):OUTPUT OF AI SCHOLARSHIP ADVISER



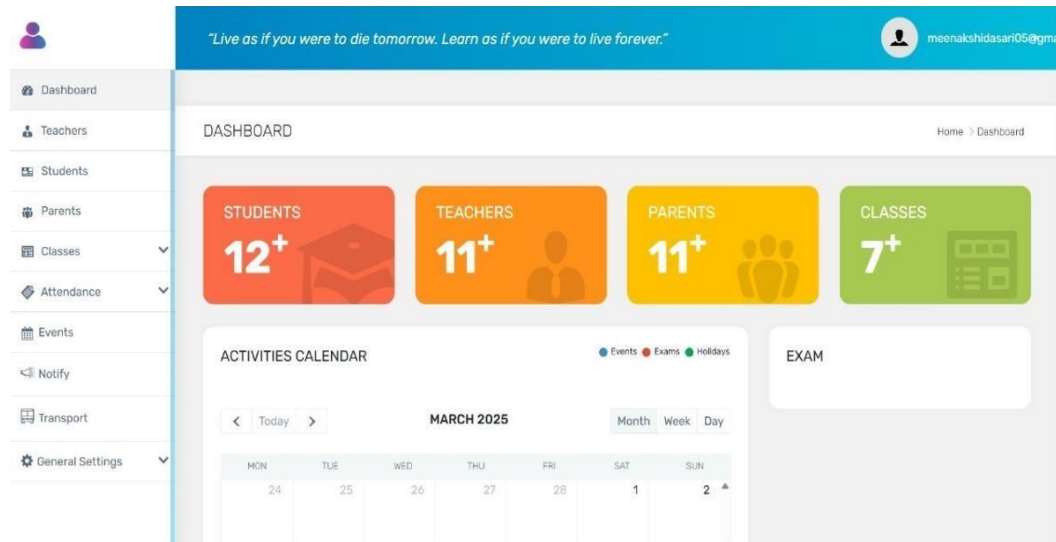
FIG(5):UPSKILLING OPPORTUNITES



FIG(6):STUDENT MOTIVATION BOT



FIG(7):FLEXIBLE SCHOOL MANAGEMENT



Fig(8):Dashboard of Felixible school Managemnt System

VI. CONCLUSION

The **Implement Software Solutions to Reduce Student Dropout Rates at Different Stages of Education** project efficiently solves the problem of student retention by taking advantage of **machine learning algorithms, predictive modeling, and an easy-to-use web application**. Through the use of **Random Forest with Gradient Boosting**, the system correctly identifies vulnerable students, which allows for interventions in a timely manner. The **Streamlit-based dashboard** offers real-time information, enabling teachers to monitor student progress, attendance, and provide individualized support. Further, the integration of the **AI Scholarship Advisor** via the Hugging Face API guarantees students receive scholarship recommendations that are applicable to them, encouraging financial aid and motivation towards further education.

This holistic solution enables **early identification, focused interventions, and sustained involvement, thus minimizing dropout** at all levels of education. Additional improvements in the future can **encompass improved predictive power, linking with other student support facilities, and inclusion of other types of educational institutions to drive greater impact**.

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