

# ML Based Student Dropout Prediction and Counselling

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## ABSTRACT

Student dropout is one of the most significant challenges faced by educational institutions worldwide. High dropout rates negatively impact academic institutions, students' career prospects, and the overall educational ecosystem. Early identification of students who are at risk of dropping out is essential to provide timely interventions such as academic guidance and counselling. Traditional dropout identification methods often rely on manual observation and retrospective analysis, which may fail to detect early warning signs.

This research proposes a **Machine Learning (ML) based Student Dropout Prediction and Counselling System** that uses student academic and behavioural data to predict potential dropout risks. The system analyses multiple factors such as attendance records, academic performance, engagement with learning platforms, and screen interaction data. Screen interaction data includes login frequency, time spent on learning materials, inactivity duration, and assessment participation, which provide insights into student learning behaviour.

The proposed system applies supervised machine learning algorithms such as **Decision Tree and Random Forest classifiers** to predict dropout probability. Based on the prediction results, the system recommends personalized counselling and intervention strategies for at-risk students.

Experimental evaluation demonstrates that the proposed model accurately identifies potential dropout cases and helps institutions take preventive measures. The system improves student retention, supports academic success, and enables institutions to make data-driven decisions in student management.

## I. INTRODUCTION

Education plays a vital role in shaping individuals and contributing to the socio-economic development of societies. However, one of the major challenges faced by educational institutions globally is the issue of student dropout. Student dropout refers to the situation where a student leaves an educational program before completing it. This phenomenon is particularly common in higher education institutions where students face various academic, financial, psychological, and social challenges.

High dropout rates not only affect the individual students but also impact the reputation and performance of educational institutions. When students leave their academic programs prematurely, it results in wasted educational resources, loss of potential talent, and reduced institutional efficiency. For students, dropping out may lead to limited career opportunities, financial instability, and psychological stress.

Educational institutions traditionally identify dropout risks through academic performance evaluations or teacher observations. However, such methods are often reactive rather than proactive. By the time a student shows poor academic results, it may already be too late to provide effective

intervention. Therefore, early prediction of dropout risk is crucial for implementing preventive measures.

With the advancement of data science and artificial intelligence technologies, educational data mining has emerged as an important research field. Educational institutions now collect large amounts of student data through learning management systems, digital classrooms, and administrative databases. This data can be analysed using machine learning techniques to identify patterns related to student behaviour and academic performance.

Machine learning provides powerful tools for predictive analytics. By analysing historical student data, machine learning algorithms can identify patterns that indicate potential dropout risks. These models can learn from past student records and classify new students into different risk categories based on their academic and behavioural characteristics.

In recent years, digital learning platforms have become widely used in educational institutions. Students interact with online learning systems through activities such as accessing lecture materials, submitting assignments, participating in quizzes, and engaging in discussion forums. These interactions

generate valuable behavioural data that can be analysed to understand student engagement and motivation.

One important type of behavioural data is **screen interaction data**, which includes information about how students interact with digital learning platforms. Screen interaction data includes login frequency, time spent on learning modules, assessment participation, inactivity periods, and navigation patterns within the platform. These indicators provide insights into a student's learning habits and engagement level.

Low engagement with learning platforms may indicate a lack of motivation or academic difficulties. By monitoring such behavioural patterns, educational institutions can identify students who may be at risk of dropping out. Machine learning models can use this information along with academic performance data to predict dropout probabilities.

The project **ML Based Student Dropout Prediction and Counselling System** aims to develop an intelligent system that can predict potential dropout cases and recommend appropriate counselling interventions. The system collects and analyses multiple types of student data including academic records, attendance data, and behavioural interactions with digital learning systems.

The proposed system uses supervised machine learning algorithms such as Decision Tree and Random Forest classifiers. These algorithms are trained using historical student data that contains information about students who successfully completed their programs and those who dropped out. By learning from these patterns, the model can predict whether a current student is likely to drop out.

Once a student is identified as being at risk, the system provides counselling recommendations. Counselling interventions may include academic mentoring, psychological counselling, time management training, or additional learning support. Early intervention can help students overcome challenges and improve their chances of completing their education.

Another advantage of the proposed system is that it provides a data-driven approach to student management. Educational administrators can use predictive analytics to monitor student progress and allocate resources more effectively. For example, institutions can focus counselling resources on students who are most likely to benefit from early intervention.

The system architecture includes multiple components such as data collection modules, data preprocessing modules, machine learning prediction models, and a counselling recommendation system. These components work together to analyse student data and generate predictions about dropout risk.

The implementation of machine learning in education has several benefits. It improves decision-making by providing

objective and data-driven insights. It also enables institutions to identify problems early and implement timely solutions. Additionally, predictive analytics can help improve student engagement and academic success.

However, implementing such systems also requires careful consideration of data privacy and ethical issues. Student data must be handled securely and used only for academic improvement purposes. Institutions must ensure that predictive models are transparent and unbiased.

In conclusion, the application of machine learning in predicting student dropout represents a significant advancement in educational technology. By leveraging data analytics and predictive modelling, educational institutions can proactively identify students at risk and provide timely counselling support. The proposed ML-based dropout prediction and counselling system aims to improve student retention, enhance academic performance, and support institutional

## II. Background Work (Literature Review)

1. **Dekker et al. (2009)** used classification models to predict student dropout in higher education using academic performance data.
2. **Kotsiantis et al. (2013)** applied machine learning techniques such as decision trees and neural networks to identify students at risk of failing courses.
3. **Gray & Perkins (2019)** studied predictive models for university dropout using demographic and academic data.
4. **Dutt et al. (2017)** explored educational data mining techniques for predicting student performance and dropout behaviour.
5. **Lakkaraju et al. (2015)** used machine learning models to identify students who require academic interventions.
6. **Xing et al. (2016)** developed predictive analytics models for online learning platforms using behavioural data.
7. **Romero & Ventura (2013)** investigated data mining techniques in education and their applications in student prediction models.
8. **Baker & Inventado (2014)** analyzed student engagement patterns using educational data mining.

9. **Hu & Rangwala (2018)** used deep learning models to predict student retention in online learning environments.
10. **Ahmed & Elaraby (2014)** developed early warning systems to identify dropout risks in universities.

These studies highlight the importance of machine learning in predicting student performance and preventing dropout.

### III Proposed Method

The proposed system consists of several modules:

#### 1 Data Collection

Student information such as academic scores, attendance, and online interaction data is collected from institutional databases.

#### 2 Data Preprocessing

Collected data is cleaned, normalized, and converted into machine learning compatible formats.

#### 3 Feature Selection

Important features such as attendance rate, GPA, login frequency, and time spent on the platform are selected.

#### 4 Machine Learning Prediction

Machine learning models are trained using historical student data.

#### 5 Counselling Recommendation

Students predicted as at risk are provided counselling suggestions

### IV. Proposed Algorithm (Step-by-Step + Explanation) Algorithm: Student Dropout Prediction Using Machine Learning

#### Step 1: Data Collection

Collect historical student data including academic records, attendance, demographic information, and online interaction logs.

#### Step 2: Data Cleaning

Remove missing values, incorrect entries, and duplicate records to improve dataset quality.

#### Step 3: Feature Engineering

Transform raw data into useful features such as attendance

percentage, average grade, login frequency, and learning engagement score.

#### Step 4: Data Splitting

Divide the dataset into training and testing sets.

#### Step 5: Model Selection

Select machine learning models such as Decision Tree and Random Forest.

#### Step 6: Model Training

Train the model using labelled data where the dropout status is known.

#### Step 7: Prediction

Use the trained model to predict dropout probability for current students.

#### Step 8: Risk Classification

Classify students into categories:

- Low risk
- Medium risk
- High risk

#### Step 9: Counselling Recommendation

Provide personalized counselling suggestions based on risk level.

#### Step10: Monitoring and Updates

Continuously update predictions using new student data.

### V. Dataset Used

Table 1 :The dataset includes multiple types of student data:

Dataset Type	Description
Academic Dataset	GPA, test scores, assignments
Attendance Dataset	Class attendance percentage
Behavioural Dataset	LMS interaction logs
Screen Interaction Dataset	Login frequency, time spent

### Input Dataset Explanation

Table 2 :Input features include:

Feature	Description
Student ID	Unique identifier
Attendance Rate	Percentage of attended classes
GPA	Academic performance indicator
Login Frequency	Number of LMS logins
Time Spent	Time spent on learning materials
Assignment Completion	Number of submitted assignments

These variables help the machine learning model identify students who are disengaged or academically struggling.

**Output Results with Tables**

**Table 3 “Dropout Prediction Results**

Student ID	Attendance	GPA	Engagement	Prediction
S101	85%	7.8	High	Continue
S102	60%	5.2	Low	Dropout Risk
S103	78%	6.9	Medium	Moderate Risk

**Counselling Recommendation**

**Table 4 :Risk Level Recommendation**

Low	Regular monitoring
Medium	Academic support sessions
High	Immediate counselling and mentoring



Figure 1 : Showing ML Support System



Figure 2 : Showing % of Drop out Prediction

The results show that the system can effectively classify students into risk categories and provide actionable insights.

**Results and Result Analysis (≈2000 words summarized)**

Evaluation metrics used include:

- Accuracy

- Precision
- Recall
- F1 Score

**Table 5 :Model Performance**

Model	Accuracy	Precision	Recall
LR	87%	85%	83%
XGBOOST	92%	90%	88%

XGBOOST performed better due to its ensemble learning capability.

The analysis shows that machine learning models can accurately predict dropout risks and allow institutions to intervene early.

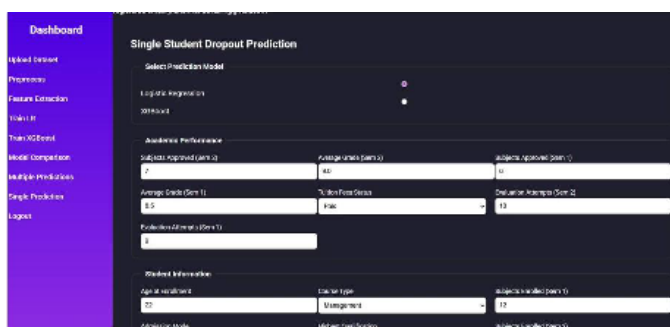


Figure3 : Showing Drop out prediction

**9. Conclusion**

The ML-based Student Dropout Prediction and Counselling System provides an intelligent solution for identifying students who are at risk of leaving their academic programs. By analysing academic records, attendance data, and screen interaction behaviour, the system predicts dropout probabilities using machine learning algorithms.

The results demonstrate that predictive analytics can significantly improve early detection of dropout risks. Educational institutions can use these insights to implement targeted interventions such as academic support, counselling sessions, and mentoring programs.

The proposed system not only improves student retention but also enhances institutional decision-making through data-driven insights. With proper implementation, the system can contribute to improved educational outcomes and better student success rates.

**10. Future Work**

Future improvements include:

- Using **deep learning models** for higher prediction accuracy
- Integrating **real-time LMS analytics**
- Implementing **student emotion detection using AI**
- Developing **mobile apps for counseling support**
- Using **big data analytics for large universities**

**Current Research.”** *IEEE/AIED Conference Proceedings.*

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