

AI-Powered Rural Student Dropout Early Warning System with Explainable Predictions, SMS Alerts, and Government Scheme Recommendations

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Abstract—Student dropout is a major concern in rural education systems. This process is controlled by a variety of known and unknown variables. Financial difficulties, poor academic performance, a lack of family support, health issues, migration, and other unspecified situations are the primary causes for many pupils dropping out of school. The driven method follows some machine learning algorithms to examine a range of data, including attendance trends, academic achievement, demographic information, and financial circumstances. Using the analysis, the algorithm determines which kids are most likely to drop out. It also contains an alarm system to assist and inform the case in order to place it under parental supervision, as well as a government program recommendation system. The model contains explainable AI (XAI) techniques, offering lucid and interpretable reasons behind each prediction.

Index Terms—AI (XAI) methods, alert system, Demographic details, government scheme recommendations, machine learning algorithms.

I. INTRODUCTION

Education plays a vital role in the overall development of a nation. But student dropout continues to be a major issue, especially in rural areas where resources and support systems are limited. Many students discontinue their education due to a combination of factors such as financial constraints, low academic performance, lack of long commutes between home and school, health-related concerns, early work obligations, and parental guidance.

These difficulties are erecting significant obstacles that keep students from finishing their education,

which ultimately has an impact on both the nation's and each person's overall development.

The majority of rural schools monitor student performance using the widely used attendance registry method. Only when the student finally recognizes that they are not attending class regularly do the teachers and administrators become aware of this. his disengagement from education. This delayed information affects the time to process what could have been done to stop this. And also, there are many other students who need support but don't readily get the benefits from government or non-government schemes. As they are in very poor condition, they may not be having direct exposure to the internet or social media. Hence, they get deprived of these things, which they had to get for their upliftment.

In recent trends, the advancement of technology, which we are truly aware of, can really save us from this mishap. As, particularly in the field of artificial intelligence (AI) and machine learning, there is immense growth of technology, there is hope of transforming the traditional education system into intelligent and fruitful solutions. This project is designed specially to predict and prevent student dropouts before they can happen. The system collects and analyzes various datasets of students, such as attendance records, academic performance, family income, education status of their parents or guardians, distance to school, their health conditions, behavioral patterns, and many other factors. By using machine learning algorithms, the system evaluates these factors to generate a dropout risk score for each student and classifies them into different risk levels such as low,

medium, or high. Here we have also integrated Explainable AI (XAI) techniques, which will provide the transparency and appropriate reasons for its choices. The proposed system also includes an SMS alert mechanism that can notify their parents about such situations in their regional languages too. Also, it includes a suitable government welfare scheme based on the student's specific needs, such as scholarships, transportation support, nutrition programs, etc. Ultimately this will contribute to improving the educational background of a child, its holistic growth, and also the development of the nation.

II. LITERATURE REVIEW

Based on the problem statement, there are similar other solutions, and research was conducted on them. Some were successful, and the parts of their research are as follows: Embarak & Hawarna discussed and revolutionized the model with the title "Enhancing Students with XAI-Powered RADAR: An Automated AI-Driven System for Early Detection of At-Risk Students," which approached tracking the student's overall performance, including other relevant factors [1]. Guzmán, Barragán & Cala Vitery have done a

systematic review identifying all the reasons for this sad reality [2]. Bania & Kvernmo analyzed and researched "Tertiary Education and Its Association with Mental Health Indicators and Educational Factors Among Arctic Young Adults" [3]. Troester-Trate investigated the core reasons such as food insecurity, childcare, transportation, etc. [4]. Castleman & Meyer showcased how the text messages can improve academic outcomes in schools and colleges with administrative and academic procedures [5]. Gildehaus et al. conducted research based on a "Unique Approach to Supporting Underrepresented Students in Biomedical Research" [6]. Hines et al. analyzed how mental health influences academic and social processes, emphasizing the "fire to make steel" resilience perspective in overcoming adversity [7]. Muñoz explained the dilemmas faced by a Mexican woman in completing her higher education [8]. Rapley al. gave a direct correlation between a student's dedicated educational preparation and more. [9]. Ramírez al. located the reason for lack of adaptation to the higher education institution [10]. Nishat et al. found that empowering students to solve study-related problems and fostering participation in tutoring increased average GPA [11].

Reference Number	Author & Year	Title	Key Findings	Research Gaps or Limitations
[1]	Embarak & Hawarna (2024)	Enhancing Student Success with XAI-Powered RADAR: An Automated AI-driven System for Early Detection of At-risk Students	Developed the RADAR system utilizing Explainable AI (XAI) and a multi-modal approach (personality, academic progress, current academic concepts progress, and soft skills). The system achieved "high accuracy" in continuous performance prediction.	Research was heavily focused on the implications of pilot study implementation rather than long-term longitudinal outcomes.
[2]	Guzmán, Barragán & Cala Vitery (2021)	Dropout in Rural Higher Education: A Systematic Review	A comprehensive systematic review identifying 59 variables across four core determinants: Individual, Socioeconomic, Academic, and Institutional.	Findings lack generalizability due to marked social asymmetries; the search was restricted to the Scopus database and limited to English-language publications.
[3]	Bania & Kvernmo (2016)	Tertiary Education and its Association with Mental Health Indicators and Educational Factors Among Arctic Young Adults	Established a significant association between parental education levels and higher education completion, with varying impacts observed between men and women.	Study findings are contextually specific to Arctic young adults, limiting broader application to other geographic cohorts.

[4]	Troester-Trate (2020)	Food Insecurity, Inadequate Childcare, & Transportation Disadvantage: Student Retention and Persistence of Community College Students	Investigated the intersection of food insecurity and transportation disadvantage; noted that interventions such as assisted meal plans did not significantly impact student retention.	The study was constrained by a small sample size, which limits the statistical power of the results.
[5]	Castleman & Meyer (2020)	Can Text Message Nudges Improve Academic Outcomes in College? Evidence from a West Virginia Initiative	Demonstrated the efficacy of "text message nudges" as a low-cost intervention for assisting students with administrative and academic procedures.	Observed that rural students often enrol for fewer credits per semester, which negatively affects timely graduation results.
[6]	Gildehaus et al. (2019)	The Research, Advising, and Mentoring Professional: A Unique Approach to Supporting Underrepresented Students in Biomedical Research	Focused on the efficacy of the Research, Advising, and Mentoring Professional (RAMP) approach for supporting underrepresented student populations.	Study scope was limited by a small, highly specialized sample within the biomedical research discipline.
[7]	Hines et al. (2015)	"It Takes Fire to Make Steel"	Analyzed how mental health influences academic and social processes, emphasizing the "fire to make steel" resilience perspective in overcoming adversity.	The specific focus on African American rural students may lack generalizability to different demographic or ethnic groups.
[8]	Muñoz (2013)	"I Just Can't Stand Being like This Anymore": Dilemmas, Stressors, and Motivators for Undocumented Mexican Women in Higher Education	Examined the dilemmas faced by undocumented Mexican women, finding that social pressure and systemic racism act as primary drivers of demotivation.	The specific legal and residency status context serves as a significant limiting factor for general application.
[9]	Rapley et al. (2008)	Enrolled Nurse to Registered Nurse: Is There a Link between Initial Educational Preparation and Course Completion?	Detailed a direct correlation between a student's initial educational preparation and their eventual successful course completion.	Results are highly specific to the nursing discipline and may not translate to other professional training programs.
[10]	Ramírez et al. (2020)	Perfiles de riesgo de deserción en estudiantes de las sedes de una universidad colombiana	Identified "lack of adaptation to the Higher Education Institution (HEI)" as the primary determinant for student desertion in the Colombian university context.	The research was localized to specific regional branches of a single university system.
[11]	Nishat et al. (2020)	Empowering Tertiary Level Students to Solve Their Own Study-Related Problems to Improve Study Performance	Found that empowering students to solve study-related problems and fostering participation in tutoring significantly increased average GPA.	The efficacy of P&GO (Retention and Graduation Plans) is limited by the requirement for "active participation" from students as a critical variable.

Figure 1 Summary of review papers

III. METHODOLOGY

The formulation of our model follows a systematic approach to make sure it gives accurate prediction and practical usability. The methodology is structured with core AI technologies such as Natural Language Processing (NLP), Machine Learning (ML), rule-based, and explainable AI. This framework ensures an efficient, data-driven smart management system.

A. Data Collection and Processing

Data collection is performed by gathering student-related information from various sources. This includes attendance records, academic performance (marks and grades), demographic details, family income, parental education, distance from school, and health or behavioral factors. These attributes are chosen because they directly or indirectly influence dropout rates. Collected data undergoes data

preprocessing. Here, missing values are handled, incorrect or inconsistent data is removed, and all features are normalized to maintain uniformity. The statistical approach has been brought into force to identify the most impactful factors contributing to dropout prediction.

B. AI-based constructive simulation and transparency methods

Here, machine learning classification algorithms are applied. These models analyze patterns in the dataset and classify students into three categories: low risk, medium risk, and high risk of dropout. Then the model is capable of learning relationships between input features and dropout behavior through training. NLP allows the system to understand the user question, also assist, and provide intelligent responses like a virtual tutor.

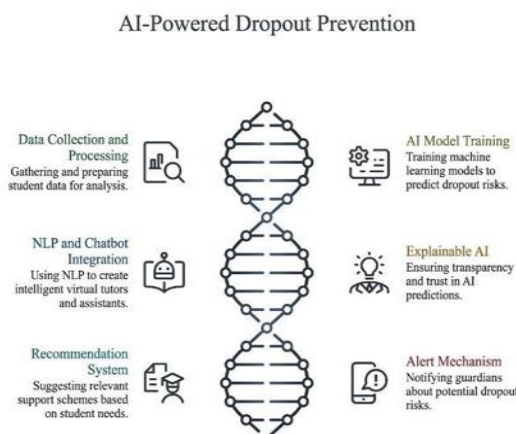


Figure 2. Systematic procedure of working model

Also, ML learns from data, providing the best answers over time. The model is trained on educational content and the datasets provided and predicts the hyped responses based on the patterns. Rule-based AI provides the fixed responses based on the conditions. A combination of ML and NLP works as a chatbot, working like a virtual assistant. To ensure transparency, Explainable AI (XAI) techniques are integrated. These methods provide clear explanations for each prediction, such as identifying whether low attendance or financial issues contributed more to the risk. This helps teachers and administrators trust and understand the model's decisions more. Additionally, a recommendation system is implemented to suggest relevant government schemes based on the student's needs. Hence, students facing financial issues may

receive scholarship recommendations, while those with transportation issues may be suggested travel support schemes. If integrated with an API, the smart SMS alert mechanism system can notify the guardians about the risk of dropout before it's too late.

Hence, the system is deployed for continuous monitoring, allowing schools to locate risks faced by the students and take preventive measures at the right time.

IV. RESULT AND EVALUATION

The accuracy of the driven system is assessed using rule-based smart system, metrics to ensure its effectiveness and reliability. At first, the model's predictive capability is measured using accuracy, which indicates how correctly the system labels students into risk categories. The harmonic mean balances both precision and recall, providing an overall performance measure. The results show that the model performs efficiently in identifying high-risk students at an early stage. This early detection enables schools to take timely actions, making less cases of student dropout. The main and important phase of the system which is addition of "Explainable AI," improving the transparency of the given output. Teachers can clearly see the reasons behind the prediction. This builds trust and allows better decision-making. The SMS alert mechanism was evaluated on the basis of impact on student performance. Also, the Government Scheme Recommendation module was also tested, which matched the requirement of the condition of the student. Overall, the system demonstrates strong performance, real-world applicability, and the ability to drastically lowers the dropout rates by enabling early intervention.

V. FUTURE WORKS AND OUTCOMES

This model is proposing a remarkable change from a responsive to a progressive and aware ecosystem, causing the same to stand unique from the current methodology. In the future, the modification can be done by incorporating satellite images, notifying the reason for a child's leave by predicting the calamities that occurred nearby.

Also, Natural Language Processing can be leveraged by training it to give the emotions and other factors impacting the student's performance to teachers.

VI. CONCLUSION

Every child is special in his/her own way. The basic right of education is a right from its birth. The factors hindering this need to be lessened to enable the holistic development of the child, and also securing the nation's youth is very important. This model showcases the potential shift from a grotesque method of education to a proactive one, where the cry of every child is heard and resolved. By integrating Explainable AI (XAI), this research moves beyond "black-box" predictions, providing educators and policymakers with the specific underlying reasons such as financial instability, distance to school, or academic distortion. This proves that AI is a powerful tool for creating social balance. By predicting dropout risks early and providing a roadmap for intervention through existing government support, we can significantly reduce the educational divide and to make sure that the humbling minds from lower background have the necessary support to get fulfilled their education.

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