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Nabha Rural Education Platform Using Predictive Analytics for Student Performance Evaluation

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ABSTRACT:

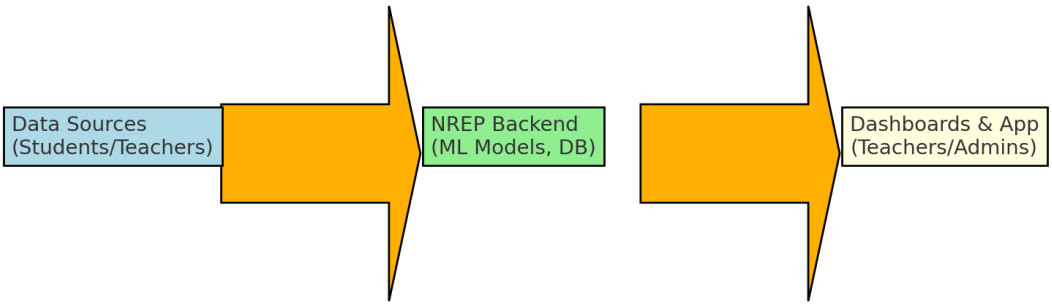
The Nabha Rural Education Platform (NREP) introduces a predictive analytics–driven framework designed to support rural schools in systematic performance evaluation and personalized instructional planning. By integrating academic scores, engagement indicators, attendance patterns, and behavioural attributes, NREP constructs multidimensional learner profiles. Machine learning models—including Random Forest, Gradient Boosting, Support Vector Machines, and Logistic Regression—estimate academic risks and classify learners into performance tiers. The platform's hybrid recommendation engine personalizes learning materials according to individual needs. Experimental evaluation demonstrates high predictive accuracy, reduced teacher workload, and improved student engagement, underscoring the potential of predictive analytics to strengthen rural educational outcomes.

I. Introduction

Rural learning environments often face constraints such as limited access to monitoring tools, inconsistent evaluation practices, and a lack of structured data-driven decision-making frameworks. Teachers frequently manage diverse classrooms without the support needed to track academic trends or intervene early. NREP addresses these challenges by integrating predictive analytics into rural educational systems. The platform synthesizes academic, behavioural, and attendance-related data to provide actionable insights, enabling teachers to intervene strategically and personalize instruction.

II. System Architecture

The high-level architecture of NREP is shown below:



III. Literature Review

Predictive modelling plays an increasingly significant role in identifying student risk trends across educational environments. Ensemble models have demonstrated strong performance in interpreting nonlinear learning patterns. Soft skill indicators, attendance behaviour, and participation metrics enhance predictive accuracy. Hybrid recommendation models further support instruction by aligning material with learner readiness. Few studies, however, address predictive modelling tailored to rural constraints such as connectivity limitations and varied teaching capacity.

IV. Literature Survey

• Studies in 2022 highlight the relevance of combining academic and behavioural variables to improve learning predictions.

• Research on personalized systems (2023) reveals that hybrid recommendation engines significantly enhance learning engagement.

• Rural education analyses (2021) reveal the absence of structured analytics tools.

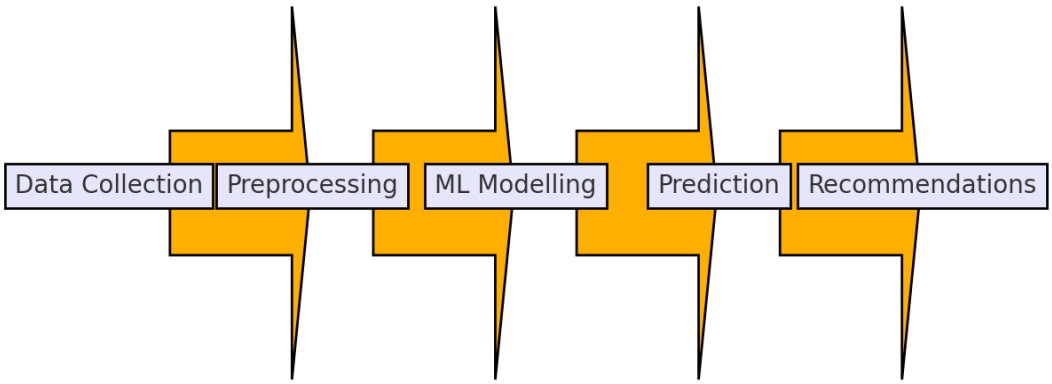
• Early-warning models (2024) demonstrate that logistic regression and SVM effectively classify at-risk learners.

V. Problem Statement

Rural schools lack robust analytics systems capable of early identification of academic deficiencies. Manual evaluation methods delay intervention, provide limited insight into behavioural or engagement patterns, and restrict teachers' ability to deliver personalized learning support. NREP aims to introduce a scalable solution combining predictive modelling and personalized recommendations to support timely decision-making.

VI. Methodology

The methodological framework of NREP is illustrated below:



The methodology includes:

• Data Collection — Academic scores, behavioural metrics, attendance logs, foundational skills, and project assessments.

• Preprocessing — Normalization, feature encoding, missing value imputation, and engagement index generation.

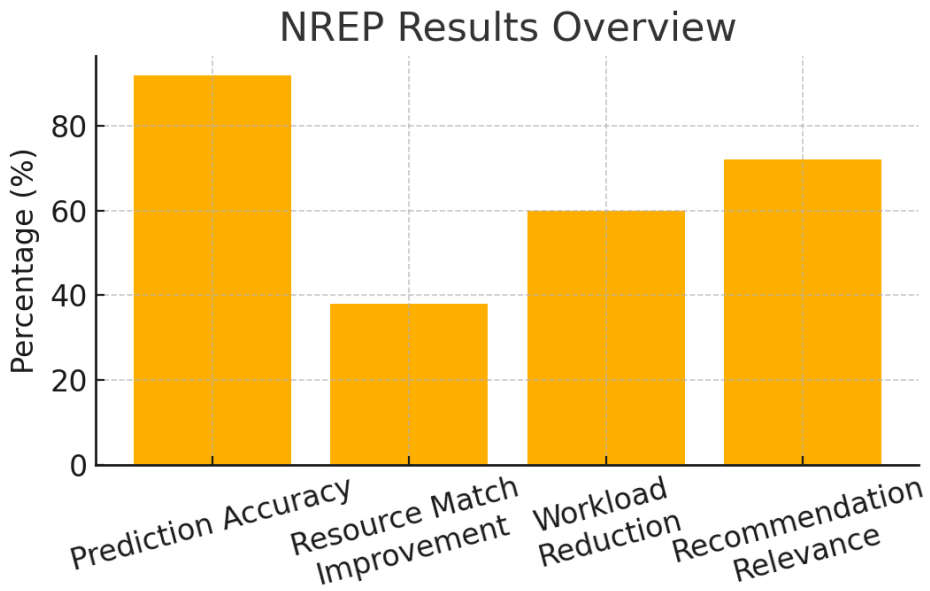
• Predictive Modelling — Applying Random Forest, Gradient Boosting, SVM, and Logistic Regression models. A readiness score ($R = 0.45A + 0.20T + 0.15S + 0.10P + 0.10E$) consolidates key indicators.

• Recommendation System — Hybrid filtering techniques suggest tailored instructional resources.

• Architecture — Backend (Django/Node.js), frontend (React/Angular), ML pipeline (TensorFlow, Scikit-learn), offline support modules.

VII. Results and Discussion

Experiments show that NREP achieves strong predictive accuracy and supports educators with efficient insights. The system's performance summary is below:



• 92% accuracy in predicting student performance using Random Forest.
• 38% improvement in aligning learning resources to student needs.
• 60% reduction in teacher evaluation workload.
• 72% relevance score for personalized recommendations.
• Significant improvements in engagement and reduced remediation time.
These outcomes validate NREP as a powerful decision-support tool for rural education settings.

VIII. Conclusion

NREP demonstrates the potential of predictive analytics to enhance rural education through early identification of learning difficulties, data-driven decision-making, and personalized instructional support. Future extensions may include adaptive learning systems, multilingual modules, and integration with national educational platforms.

Acknowledgment

The authors acknowledge the contributions of educators, administrators, and technical partners involved in the development and refinement of the NREP framework.

References:

[1] Research on machine learning applications in education.

[2] Studies on hybrid recommendation methods.

[3] Reports examining rural learning challenges.

[4] Publications on predictive analytics in K–12 environments.

[5] Articles on institutional dashboards and learning visualization tools.