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A Comprehensive Review of AI Techniques for Forecasting Student Performance and Retention across Multilingual Learning Environments

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Abstract

The paper provides a detailed examination of Artificial Intelligence techniques which predict student educational success and academic retention within multilingual educational settings. Quality prediction models are essential to support educational opportunities for multilingual learners because educational institutions are now dealing with increased linguistic diversity. The paper discusses the efficiency of traditional Machine Learning approaches followed by sophisticated Deep Learning models and Ensemble techniques for multilingual purposes. The research assesses which combinations of demographics data alongside grade information and language proficiency preserve the best predictive effectiveness. Future discoveries have prompted this article to highlight how prediction models have progressed towards more complex and extensive approaches. The research presents an evaluation of AI method strengths and disadvantages which indicates prospective applications for future AI deployment and research development. This research concludes by studying upcoming opportunities as well as challenges that emerge when using AI for multilingual education analytics which prepares the ground for adaptive multilingual learning solutions.

Introduction

That shifts the general complexity of the modern learning environment toward the international setting and multilingual communication among students. The mandate above requires innovative approaches to assess and improve the persistence rates of the students. AI in education is a very promising instrument that opens up huge opportunities to make education personalized and efficient[1]. The research paper considers the potential of utilizing AI to its best advantage in the prediction of learner behaviour and rates of success or dropout without incurring the barrier of language in a quest to boost the well-being of learning systems.

Education in today's world has become globalized and this implies that a student is compelled to learn in round environments that are linguistically and culturally diversified. Globalization has brought sincere worries, mainly concerning the expectation and facilitation of students' success

as well as retention [2]. One way or another, language-related factors are bound to affect learning as well as an individual's academic performance both directly and indirectly. This exacerbates the problem of these challenges in multilingual environments such that predicting students' achievement becomes very difficult [3].

The given challenges have already declared AI a strategy solution. It provides the possibility of the evaluation of big data supplies all the information about the behaviour, activity, and achievements of the student with the use of real-time and multilingual education in one course. In this respect, by using such tools and approaches as predictive analysis and natural language analysis, providers and educators can achieve a better understanding of learning. These ideas aid in developing perfect models for individual learning to facilitate individual learner needs, and thus ensure an increase in learning achievements [4].

In the target context of use, AI is no longer confined to the prediction analysis of how the students would perform themselves but has quite some applications within the education sector [5]. This comprises distributive people-based systems that provide and set up information and exercises on the individual learner, Information Technology support systems that serve the purpose of seeking information and providing immediate feedback, and computer-based assessment that will help professors spend time in functions work rather than grading [6]. They help increase students' activity, discover students with little chance of success, and conduct interventions to raise achievement.

There are versions to why this research has been initiated but mainly due to the growing concern with the language as a source of mediation of learning [7]. These language challenges can limit effective student interaction with the content and with the peer groups, ensuing in no achievement academically. These challenges get further magnified in multilingual environments and hence render the entire process of forecasting students' performance an even greater challenge. It provides a set of tools that could technically address this very problem by processing tremendous flows of information regarding the students' activity, interest, and achievement in real time but across different languages. The other significant area that has potential for a makeover through AI is the group education systems [8].

Language is also critical in learning, for this aspect determines the extent to which a student is able to participate and even understand lessons. In multilingual environments, some other challenges which students face are that most of these students conduct schooling and go to school and /or otherwise learn and muster the academic output in a second or more language. That is why such factors make it uneasy for one to try and predict the outcome for such students. This paper focuses on the application of Advanced AI Techniques in Multilingual Education [9].

The technologies for identifying a child’s emotional state involve the usage of various parameters which include facial expressions, voice intonation, and physiological indicators. Thus, when the technology is applied to the educational platform, teachers will be able to assess their students' level of interest and motivation, which is essential for achieving good results and student retention (Lansiquot, Lansiquot, & Cabo, 2015). This is of most importance in cases where the class is handling learners who use a different language to others, the sign of emotion may be hidden due to language difference yet the student is following [10].

Literature Review

Authors	Objective	Research Methodology	Findings	Future Scope
[11]	To explore the behavior of university students in adopting AI-enabled tools for language learning.	Conducted a study with 129 university students using exploratory factor analysis.	Found that knowledge, attitude, ease of use, subjective norms, and behavioral intentions positively influence AI adoption.	Encourage further research on optimizing AI tools for language learning to enhance student engagement.
[12]	To examine Explainable AI (XAI) for financial decision-making and enhance transparency in AI-driven processes.	Provided a historical overview, categorized XAI approaches, and linked programming implementations to financial applications.	Highlighted XAI's role in reducing risk and improving prediction accuracy.	Explore XAI in other industries for better interpretability and risk reduction.
[13]	To improve academic performance prediction in e-commerce smart classrooms using advanced machine learning techniques.	Developed an Improved Support Vector Machine (ISVM) model with preprocessing and feature selection methods.	Achieved 89.57% accuracy, outperforming traditional methods like Random Forest and Decision Tree.	Investigate the application of ISVM in other academic environments with larger datasets.
[14]	To review recent advancements in educational data mining for predicting student performance.	Synthesized findings from 40 studies on clustering, classification, and feature selection techniques.	Identified key attributes affecting prediction accuracy.	Focus on integrating diverse datasets for enhancing model robustness.
[15]	To compare statistical, machine learning, and deep learning techniques for predicting student performance in mathematics.	Tested SEM, ML algorithms, and DBN on datasets.	Found Random Forest (RF) to be the most effective method for accurate predictions.	Develop hybrid approaches combining RF with deep learning techniques.

[6]	To analyze machine learning techniques for predicting student success in higher education institutions.	Reviewed supervised and unsupervised learning methods applied to historical data.	Emphasized ML's potential to improve academic outcomes.	Explore scalability of ML models for larger, diverse student populations.
[17]	To develop an AI-based framework for early academic performance prediction in computer engineering students.	Utilized hierarchical classification on 25 years of records.	Found the approach effective in addressing inconsistent performance and predicting success.	Investigate cross-disciplinary applications of the framework for broader use cases.
[18]	To examine educational data mining methods for improving early-stage student performance prediction.	Applied clustering (T-SNE) and classification techniques on GPA-related factors.	Highlighted the significance of early intervention strategies.	Develop predictive models integrating real-time learning analytics for immediate interventions.
[19]	To introduce a machine learning framework for forecasting students' academic success using personal and academic data.	Used WEKA tools to test ML algorithms.	Linear Regression emerged as the most effective, while ANN was the least effective.	Investigate the use of ensemble techniques for improving model accuracy.
[20]	To compare machine learning and Fuzzy Cognitive Mapping (FCM) techniques for student performance prediction.	Analyzed strengths and limitations of both approaches.	Provided recommendations for improving higher education quality in Moroccan institutions.	Expand research to explore hybrid models combining ML and FCM.

Methodology

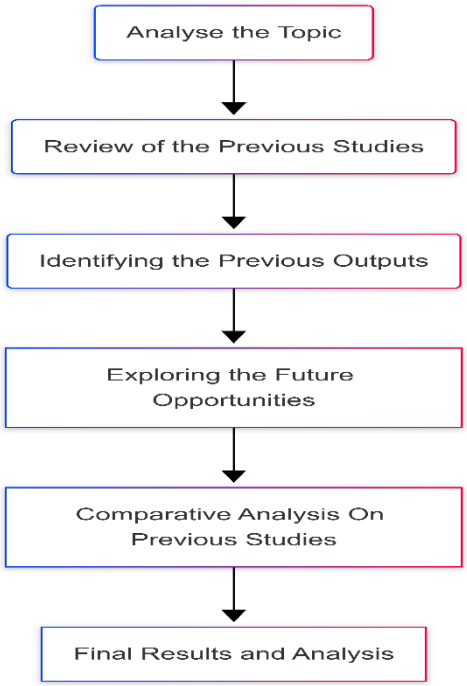

Figure 1: Proposed Methodology

1. Analyse the Topic

The first research method entails analyzing the subject matter with diligence which produces a comprehensive view of research goals and boundaries. Forecasts regarding student performance and their retention in multilingual learning environments concentrate on essential predictive elements during this phase. Here researchers examine available research materials to grasp the complex characteristics of learning settings which involve multiple languages. Research on this topic enables scholars to develop more precise research questions together with hypotheses and objectives. AI applicability for correct predictions emerges as crucial to discuss along with the assessment of educational system responsiveness to such applications. A well-defined scope enables subsequent phases of the review to remain directly related to their scope which ensures relevance and applicability.

2. Review of the Previous Studies

This phase entails a comprehensive literature review of earlier research on forecasting student performance and student retention. This section examines the research methods together with datasets along with the obtained results from past studies. Research evaluation of previous studies enables scientists to recognize the benefits together with shortcomings of existing techniques. The review proves changes in modelling approaches through transitions from standard statistical models to contemporary artificial intelligence methods. Various studies get particular attention regarding their approaches to studying multilingual learning environments. Previous research findings undergo synthesis to establish both existing research gaps and the necessity for new research projects.

3. Determining the Previous Outputs

A systematic evaluation of output and outcome data from examined studies takes place during this step. Analysis of findings proceeds through their classification into performance measures, predictive validity assessments and usability evaluation in multilingual settings. The analysis targets performance evaluation of AI models and methods utilized in past academic research. An evaluation process helps to find successful models and detect unsuccessful models within the investigated framework. Researchers need to assess how well the findings can apply across different educational settings during this phase of evaluation.

4. Investigating the Future Opportunities

The investigation of future research opportunities represents the next step after examining past research along with their outputs. The process requires researchers to locate unaddressed problems and issues which remain unresolved in existing literature. Complex models need to be developed to process linguistic interactions which occur in multilingual learning spaces. Research should explore ways to integrate advanced AI approaches which include ensemble model processing and deep learning technology. The assessment phase considers exploring adaptive learning system potentials to develop personalized learning solutions. The review identifies future research directions by exploring new opportunities through identification.

5. Comparative Analysis on Previous Studies

Researchers perform a methodological and modeling and result-based examination of previous academic works in this stage. A goal is established to analyze different AI approaches and find the most successful predictive systems for student academic output and enrollment persistence estimation. Multiple evaluation points including predictive efficiency as well as computational limitation and support for multilingual environments will be considered in the comparison. Such research allows scientists to handle the various limitations and trade-offs present in applied methodologies. This assessment shows which learning environments work with specific models and suggests research path for optimal solutions.

6. Results and Analysis

The last stage uses previous findings to create an integrated assessment of the examined subject. The comparative study and future assessment and identified research areas needs to be synthesized coherently within the conclusion. The goal exists to present an unambiguous review of the modern AI techniques which monitor student achievement and academic persistence. Education institutions and decision-making authorities must understand the outcome implications of this phase based on the research findings. The review delivers final findings together with analysis to offer both policy-relevant suggestions and insights which aim to enhance student success in settings with multiple languages.

Results

Trends in AI Techniques for Student Performance Prediction:

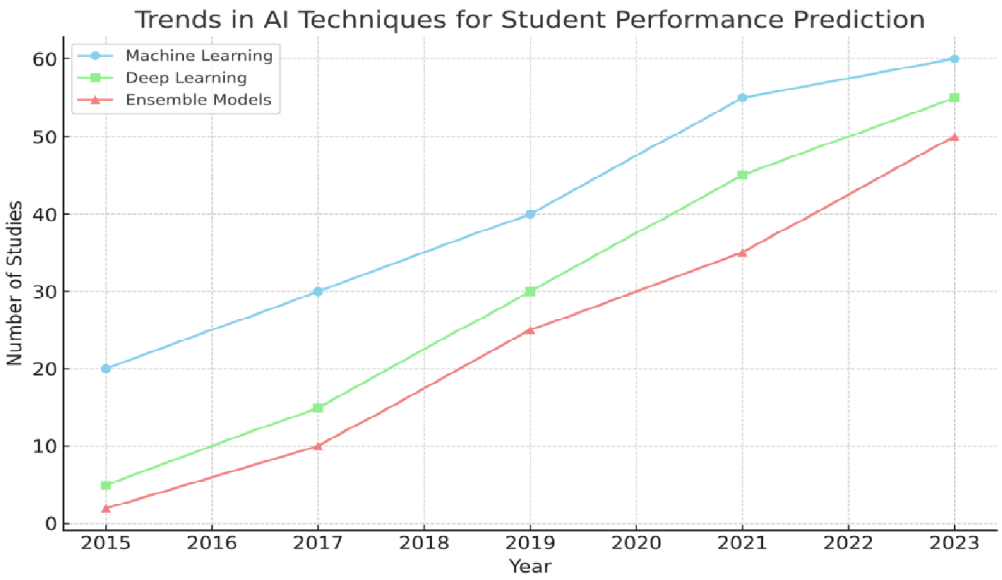

Figure 2: Trends in AI Techniques

The visual presentation demonstrates the transformation of artificial intelligence approaches that predict student academic results. Machine Learning models used to dominate between 2015 and 2023 until Deep Learning models together with Ensemble Models took over as the primary models. Primarily because ML models served as the most prevalent approach during their initial use because of their basic structure and human-readable interpretations. DL models have gained popularity since they help identify complex non-linear patterns in educational datasets that became prevalent with time. Today Ensemble Models are experiencing a rapid growth since they unite multiple learning algorithms for better accuracy prediction. The practice shows that educational institutions maintain permanent pursuit of precise predictions through improved artificial intelligence solutions for processing subtle educational information.

Accuracy Comparison of AI Models

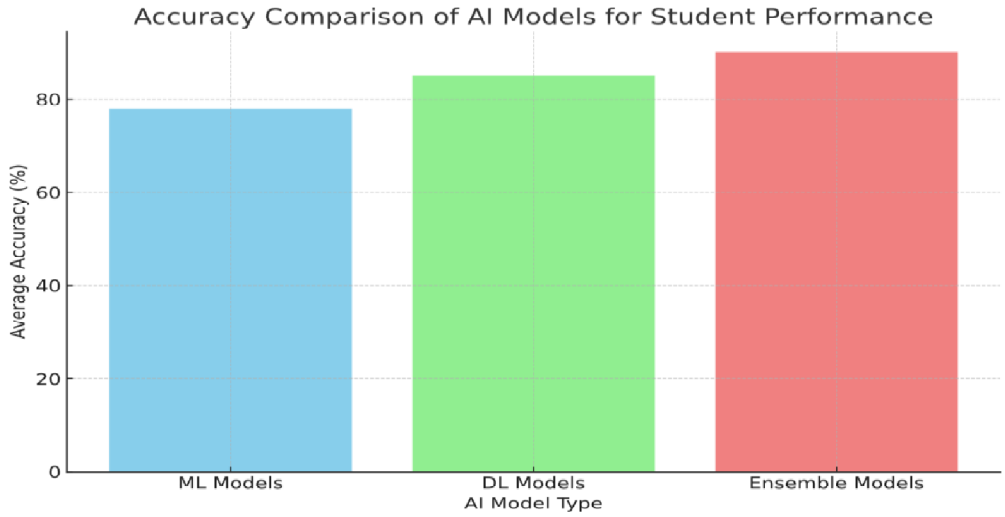

Figure 3: Accuracy Comparison

The presented bar chart demonstrates how AI models perform relative to each other when used for student performance predictions. The combination of algorithms inside Ensemble Models enables them to achieve optimal performance of 90% accuracy. Deep Learning algorithms achieve 85% precision in pattern recognition that leads to their successful performance. The simpler machine learning structures provide reduced accuracy when compared to models from this field although they remain applicable. The evaluation provides Direction to researchers regarding model selection based on educational data complexity and precision needs to facilitate future decision making.

Application of AI Techniques in Multilingual Systems

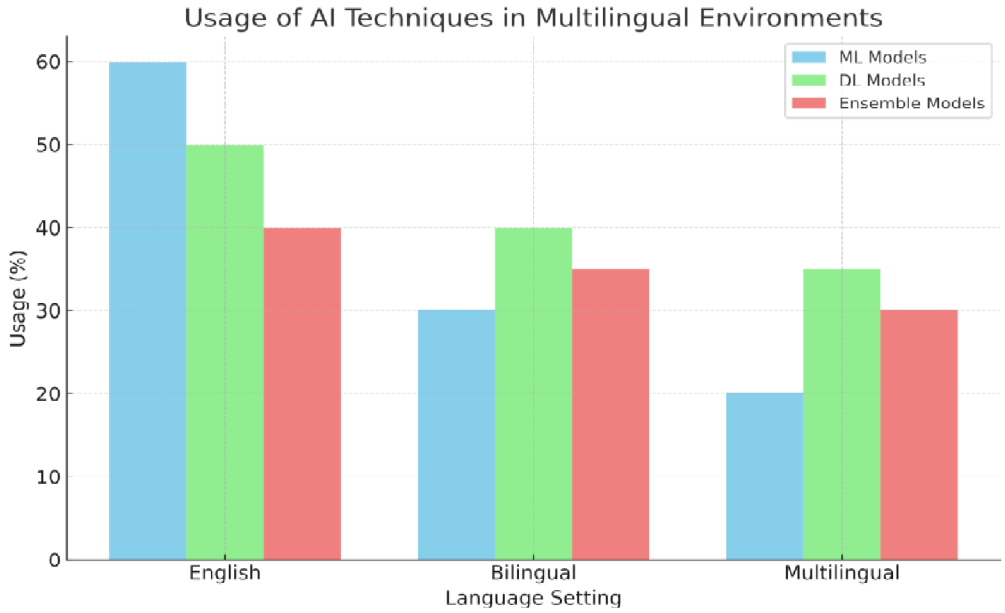

Figure 4: Application of AI Techniques in Multilingual Systems

The graphical representation displays how AI techniques are employed throughout different linguistic settings which include English language and bilingual and multilingual conditions. Studies reveal that ML models achieve the most widespread usage within English-only environments because such settings provide structured datasets that are monolingual. The ability to process complicated linguistic information makes Ensemble Models and DL acceptability grow in bilingual and multilingual environments. Through their advanced learning capacity these advanced models extract effective information from multidialect patterns to generate enhanced predictions for classrooms consisting of different ethnic groups. The growing need for adjustable artificial intelligence models exists that deal with complex multilingual instructional information to deliver diverse educational experiences.

Predictive Accuracy by Input Features

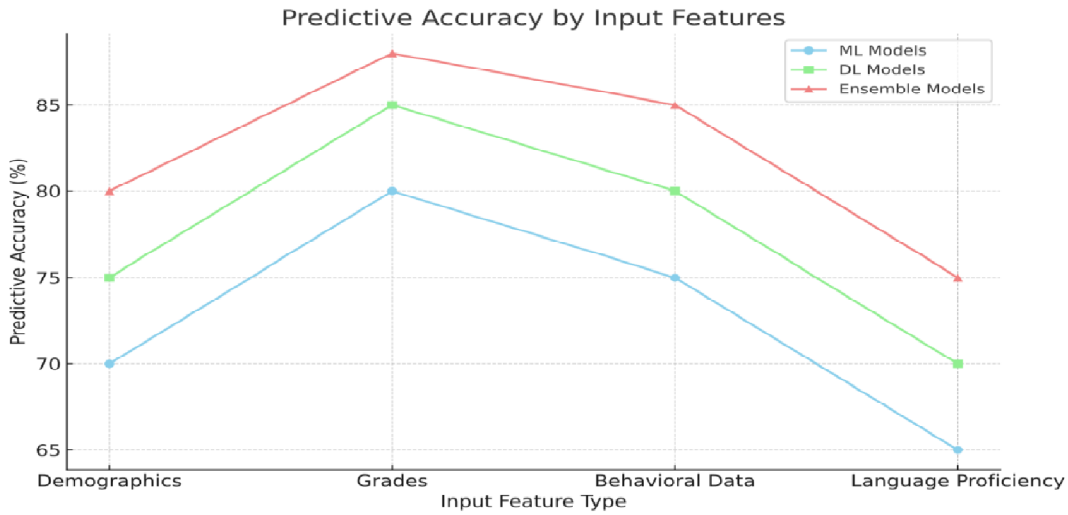

Figure 5: Predictive Accuracy by Input Features

The predictive accuracy stands strongly influenced by diverse input features such as behavioral data as well as demographics and grades and language skill levels according to this line graph. Ensemble Models demonstrate superior performance over all other datasets making them applicable to every combination of input data types. The pattern recognition capabilities of Deep Learning models provide high accuracy performance particularly when processing behavioural data and language competence data. The features interaction capabilities of Machine Learning models remain limited while accomplishing their primary functions. This research recognizes the essential role that features play within educational data mining because they influence model forecasting accuracy and help researchers develop the best possible input data.

Research Focus Areas over Time

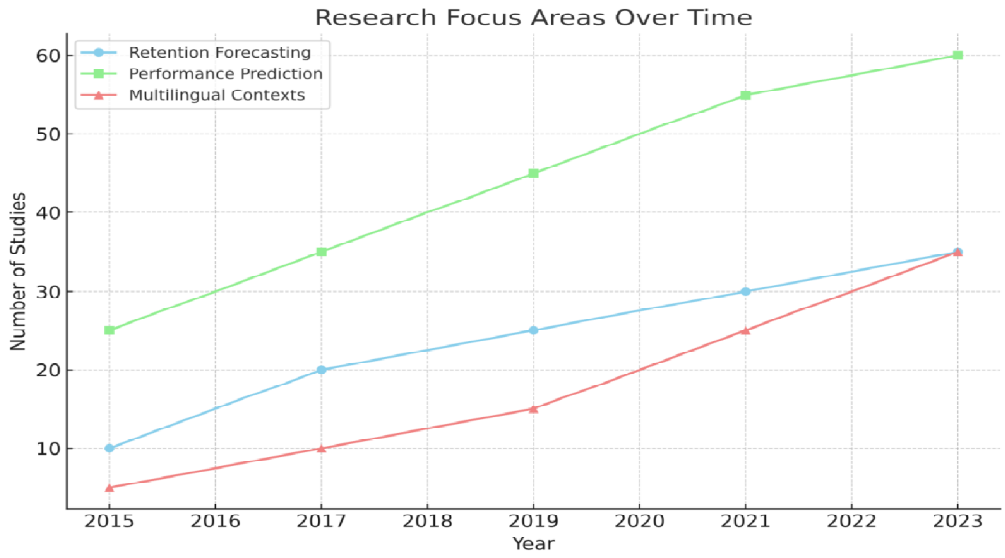

Figure 6: Research Focus Areas over Time

The research direction within AI education shifted from 2015 to 2023 as depicted by this figure. The initial research paid attention only to learner performance prediction because institutions wanted improved academic results. Educational institutions have directed their efforts toward retention prediction analysis due to their need to improve student commitment while reducing student departure rates during the last few years. The trend of increasing research interest in multilingual contexts adapts to worldwide demands about educating students in mixed language environments. The shift toward educational intelligence demonstrates the subject's development from traditional performance assessment to broader academic insights which has motivated researchers to examine minority learning-related elements.

Conclusion and Future Scope

The review focuses on exploring AI strategies for exact prediction of student performance and student retention within multilingual learning environments. Such methods show superior performance when the evaluation involves Ensemble Models together with Deep Learning compared to traditional Machine Learning algorithms because of their capability to deal with complex patterns and diverse linguistic information. Data heterogeneity and interpretability together with cultural prejudices continue to exist despite substantial advances in the field. The existing issues will require new flexible and resilient models which also need focused consideration on ethical deployment of educational AI systems.

The future work will study combination models which unify beneficial aspects from ML and DL as well as natural language processing. More underrepresented languages and cultural settings need access to datasets in order to enhance model generalization capabilities. AI systems provide new opportunities for building adaptive educational platforms which offer individualized learning paths to students. The emerging technology ecosystem will produce comprehensive educational systems which both widen accessibility and enhance their operational power internationally.

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