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Student Academic Performance Assessment Using Machine Learning – A Literature Review

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Abstract
For academic performance assessment of student, traditional methods like written exams and other manual evaluations fail to capture the student's academic performance. In professional programs like Master of Computer Applications (MCA), where students should have proficiency in various fields like coding, designing, analyzing , soft skills etc. Hence traditional assessment methods are less efficient to capture various influencing factors. Therefore by integrating academic as well as behavioural data of students, one can identifycritical performance parameters needed for performance assessment using machine learning techniques like descriptive analytics and feature selection techniques. Various Machine Learning algorithms can also be used for comparative analysis of the same. It will be helpful for proper decision making for a student in his/her own career path.
Keywords:*Machine Learning, Academic Performance Assessment, Proficiency, Feature Selection, career path*

INTRODUCTION

Traditional academic assessment methods like manual evaluation of tests, assignmentsand exams unable to capture the full academic potential of students. In modern academicera, quality education and timely academic support is must for a student.Therefore prediction and analysis by using Machine learning is one of the popular ways to discover the student's performance. The research will explore the use of machine learning (ML) techniques to assess the academic performance of student. The research will analyse the existing work to identify existing prediction methods and tools. Based on that a machine learning model will be designed which will be helpful for academic performance assessment of student.

2. Need and Scope of Study

Professional courses like MCA where students should have sufficient knowledge of design, coding, analysis, soft skill etc. which are must before entering into the job. It cannot happen suddenly during the academic year. Therefore student should be assessed throughout the year to improve his/her performance for their future/career. ThereforeMachine Learning is a powerful tool to predict student performance to enhance academic progress and career preparedness. However, there is a gap in existing research on customizing various ML models for MCA programs. Therefore this study aims to bridge this gap by identifying performance indicators of MCA program, finding out suitable ML algorithm and develop a robust model for early academic assessment and support for the student.

This study will use various machine learningtechniques to predict and assess the academic performance of student in the Master of Computer Applications program. The research will use data from various institutions including academic records as well as behavioural indicators. Various ML techniques like Logistic Regression, Decision Trees, SVM etc. will be used in predicting student outcomes. The designed Machine learning model will be helpful for educational institutions to enhance performance evaluation, academic planning, and student mentoring.

Review of Literature

The researcher has studied detailed literature to study and to trace out the gap to address the problems in the academic performance assessment of student.

To perform extensive literature survey, the researcher has followed the following way ofstudy.

- Predictive Analytics for Academic Outcomes
- Automated Grading and Instant Feedback
- Intelligent Tutoring Systems (ITS)
- Curriculum Optimization and Learning Path Analytics

Predictive Analytics for Academic Outcomes

The research (Namoun, A., &Alshanqiti, A. 2020) focused on predicting student outcomes using learning outcomes suggested improvement in model accuracy, understanding factors impacting student performance, and implementing program-level outcomes prediction and validation using multiple datasets.This literature review by (Shafiq D. A. et al 2022) explores learning analytics techniques for improving education and the learning environment using Machine Learning and Deep Learning algorithms.

Automated Grading and Instant Feedback

The literature review analyzed 121 research papers from 2017 to 2021 on automated grading and feedback tools for programming education. Most tools assessed correctness using dynamic techniques like unit testing or static analysis, but provided limited feedback. The educational system is reliant on manual grading, causing delays and inaccuracies. GRAD-AI, an advanced automated tool, combines automation with teacher involvement for precise grading, timely feedback, and personalized support. It provides real-time feedback and gap identification, enhancing learning outcomes and fostering personalized learning as AI expands (Gambo I. 2025). The study demonstrates the effectiveness of a real-time automated grading system in enhancing students' learning experiences.

Intelligent Tutoring Systems (ITS)

ITS is revolutionizing e-learning by utilizing artificial intelligence to tailor content to individual student needs, enhancing interaction between teachers, students, and tutors, and promoting self-adaptive architecture for academic monitoring (López-Goyez, J. P., 2024). The study used the R environment for statistical data analysis, examining four dependent variables: students' use of ITS, the risk of dropping out after using ITS, and the influence of assignment scenarios on students' risk of dropping out.

Curriculum Optimization and Learning Path Analytics

Tam, V., Lam, E. Y., & Fung, S. T., 2014 research presents a learning path recommendation approach that considers both static and dynamic learner parameters, adjusts difficulty levels based on real-time performance analysis, and predicts learning time and expected scores. The study explores learning path optimization (LPP) using the ACO algorithm, a popular choice for online education due to its superior results. (Zhao, J 2024) The study proposes an optimization model for mobile learning path design, based on multi-view prediction of dynamic student behaviours

Key Parameters influencing students' academic performance:

The academic performance of a student is significantly influenced by various factors, including family support, accommodation, gender, and e-learning activity, which can significantly impact their overall performance(Al-Husaini et al 2022).Student goals, teacher skills, management attitude, career choice, family support, and curriculum are key parameters that influence on student's academic performance. The research by (Al-Okaily M. et al, 2024) explores the impact of the COVID-19 pandemic on Jordanian higher education institutions, which uses mixed method approach to examine students' grades and challenges. However, challenges in infrastructure, engagement strategies, and knowledge management hinder its full replacement.

Models adopted in Existing research:

EDM is a valuable tool for predicting student academic performance in Oman. It utilizes clustering, discrimination, and convolution neural network theories. Future research can extend EDM to medical, sports, and other fields(feng G. et al 2022). The study (Jiao, P., Ouyang, F., Zhang, Q., & Alavi, A. H. 2022) develops an AI-enabled prediction model for academic performance in online engineering education.

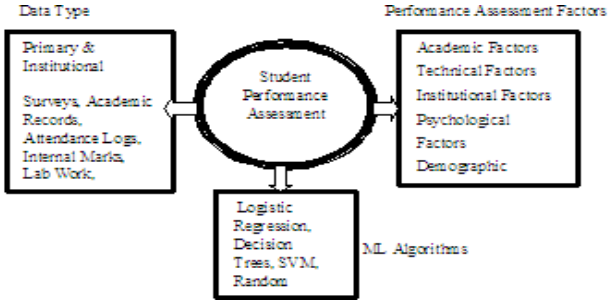

Fig. 1: Student Performance Assessment Methodology

3. Research Gap:

This study systematizes the use of machine learning to develop a customized model for student academic performance assessment. During the literature review,the researcher has been found research work based on different factors, tools and techniques.

The research by (Namoun, A., &Alshanqiti, A. 2020) focused on online learning activities, term assessment grades and academic emotions as key predictors. They suggested improvement in model accuracyand implementing program-level outcomes prediction and validation using multiple datasets.The literature review by (Shafiq D. A. et al 2022) suggests lack of exploration of Unsupervised Learning, Hybrid Machine Learning, and Semi-supervised models. Some suggested need of fully automated processes providing consistent grading, precise feedback, and better localization while reducing instructor time. (Aldriye, H., Alkhalaf, A., & Alkhalaf, M. 2019), suggested existing work should explore its long-term impact on learning outcomes, its application in diverse demographic, and its scalability in different socio-economic contexts (Song, C., Shin, S.-Y., & Shin, K.-S. 2024).ThereforePredicting student achievement is becoming an attractive research topic (Alwarthan, S. A., Aslam, N., & Khan, I. U. 2022). By focusing on this, it has been observed that there is no such unified framework to classify and prioritize key factors of student performance assessment across different educational contexts. Existing research often relies on domain-specific datasets, also lacking in generalizability across various institutions. So research aim is to design a Custom Machine Learning model for student performance assessment.

4. Problem Statement:

In professional programs like Master of Computer Applications, outcomes are critical for employability where data-driven and predictive approaches are needed. As traditional assessment methods are insufficient to predict academic outcomes and identifying at-risk students early. Therefore this research aims to bridge the gap by identifying influential academic and behavioural parameters, designing a custom ML model with suitable machine learning algorithm for assessment of student performance, personalized academic support etc.So, the researcher aims to apply machine learning model to assess student academic performance by proposing study titled,

"A MACHINE LEARNING APPROACH FOR ACADEMIC PERFORMANCE ASSESSMENT OF STUDENT".

5. Objectives

To meet the requirement, we will collect institutional data as well as records. From the obtained data, we will identify and classify the key components influencing the student academic performance.By using different machine learning algorithms, the comparative analysis can be done. Based on that a model will be designed which will be beneficial for student as well as institution for early analysis of student.

6. Research Methodology:

The researcher has planned to follow the Design and Creation research Strategy. The strategyfocuses on assessment of student academic performance using machine learning.This model will help in early identification of at-risk students and also helpful for faculty, contributing to improved student outcomes as well as institutional decision-making.

Proposed Framework/Model:

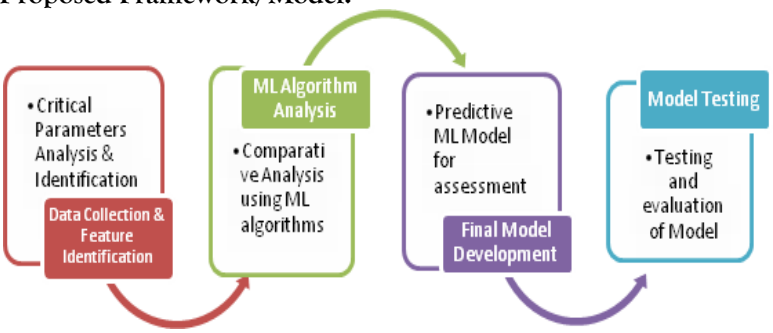

Fig.2: Proposed Framework for Predicting MCA Student Performance

Conclusion:

This study givesa scalable approach to assess the academic performance of students using machine learning techniques. Based on a literature review and a research gap, the study focuses on postgraduate MCA learners, a group often underserved by generalized academic performance models. A machine

learning model aids in early identification of at-risk learners and enables data-driven interventions by faculty, contributing to improved student outcomes, personalized academic support, and institutional decision-making.

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