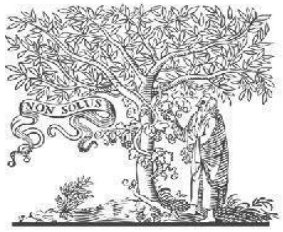
International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

COPY RIGHT



ELSEVIER
SSRN

IJIEMR Transactions, online available on 7th June 2026. Link

https://ijiemr.org/downloads.php?vol=Volume-15& issue=issue06

DOI: 10.48047/IJIEMR/V15/ISSUE 06/50

Title Predictive Diagnostics in Educational Psychology: Early Detection of Academic Burnout via Ensemble and Logistic Classifiers

Volume 15, ISSUE 06, Pages: 478 – 487

Paper Authors
SK M Siddik, Dr. G.V. Ramesh Babu

USE THIS BARCODE TO ACCESS YOUR ONLINE PAPER

To Secure Your Paper as Per UGC Guidelines We Are Providing A ElectronicBar code

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

Predictive Diagnostics in Educational Psychology: Early Detection of Academic Burnout via Ensemble and Logistic Classifiers

[1] SK M Siddik, [2]Dr. G.V. Ramesh Babu
[1]Masters of Computer Applications, Department of Computer Sciences,
SV University, Tirupati
skmsiddik4321@gmail.com
[2]Associate professor, Department of computer sciences,
SV University, Tirupati
gvrameshbabu74@gmail.com

Abstract

Study burnout has emerged as a significant challenge among students due to increasing academic pressure, prolonged screen exposure, competitive learning environments, and inadequate work–life balance. Early identification of burnout symptoms is essential to prevent adverse effects on students' academic performance, mental well-being, and overall productivity. This paper presents a Study Burnout Detection System that leverages machine learning and intelligent recommendation techniques to identify students at risk of burnout and provide personalized interventions. The proposed system employs a modern web-based architecture using React.js/Next.js and Tailwind CSS for an interactive user interface, while MongoDB serves as the backend database for secure storage and management of student data. The detection framework integrates Random Forest and Logistic Regression algorithms to analyze behavioural, academic, and self-reported psychological indicators associated with burnout. Furthermore, a rule-based recommendation engine generates tailored suggestions, including study scheduling strategies, stress-management techniques, and wellness activities based on individual risk levels. The system aims to improve prediction accuracy, enhance user engagement, and support proactive mental health monitoring in educational environments. Experimental evaluation demonstrates the effectiveness of the proposed approach in identifying burnout patterns and delivering actionable recommendations, thereby contributing to healthier learning experiences and improved academic outcomes among students.

Keywords: Study Burnout Detection, Random Forest, Logistic Regression, Rule-Based Recommendation System, Student Mental Health.

1. INTRODUCTION

Student well-being has become an increasingly important concern in modern educational environments due to growing academic demands, competitive learning ecosystems, and the extensive use of digital technologies in education. While technology has enhanced accessibility to learning resources, it has also contributed to

prolonged study hours, increased cognitive workload, and heightened stress levels among students. These factors often lead to study burnout, a psychological condition characterized by emotional exhaustion, reduced academic motivation, and diminished learning effectiveness. Study burnout not only affects academic performance but also negatively influences mental health, social interactions, and overall quality of life [1].

Burnout among students has gained significant attention from researchers and educational institutions because of its long-term consequences on learning outcomes and personal development. Students experiencing burnout frequently exhibit symptoms such as fatigue, anxiety, decreased concentration, procrastination, and loss of interest in academic activities. Traditional methods of identifying burnout often rely on manual assessments, surveys, and counseling sessions, which may not provide timely intervention or continuous monitoring. Consequently, there is a growing need for intelligent systems capable of automatically detecting burnout symptoms and assisting students before severe consequences arise [2].

Recent advancements in machine learning and data analytics have created new opportunities for developing predictive systems that can analyze behavioral and psychological patterns. Educational data generated through student interactions, study habits, academic performance, attendance records, and self-reported assessments can be leveraged to identify indicators of burnout. Machine learning algorithms have demonstrated considerable success in classification and prediction tasks across healthcare, education, and behavioral sciences, making them suitable for burnout detection applications [3].

Among the various machine learning techniques, Logistic Regression and Random Forest have emerged as reliable algorithms for predictive analytics. Logistic Regression offers a simple yet effective probabilistic approach for binary classification problems, enabling the estimation of burnout risk levels based on multiple contributing factors. On the other hand, Random Forest utilizes an ensemble of decision trees to improve classification accuracy and robustness while reducing the likelihood of overfitting. The combination of these algorithms provides a balanced framework capable of generating accurate predictions and meaningful insights regarding student burnout conditions [4].

The increasing adoption of web-based educational systems further enables the implementation of intelligent monitoring platforms that can provide real-time analysis and feedback. Modern frontend technologies such as React.js and Next.js facilitate the development of responsive and user-friendly interfaces, allowing students to interact with the system efficiently. Additionally, Tailwind CSS supports the creation of visually appealing and adaptive designs that enhance user engagement and accessibility across different devices [5]. Such technologies are particularly valuable in educational applications where usability and accessibility play crucial roles in user acceptance.

Data management is another critical component of burnout detection systems. The collection and storage of student-related information require scalable and flexible database solutions capable of handling diverse data formats. MongoDB, a NoSQL database platform, provides an efficient mechanism for storing structured and semi-structured educational data while supporting rapid retrieval and analysis. Its scalability and flexibility make it suitable for applications

involving large volumes of student behavioral and academic information [6].

While burnout detection is essential, identifying at-risk students alone is insufficient for addressing the problem effectively. Personalized intervention strategies are necessary to help students manage stress, improve study habits, and maintain a healthy academic balance. Rule-based recommendation systems offer a practical approach for delivering customized guidance based on detected burnout levels. By analyzing prediction outcomes, the recommendation engine can provide targeted suggestions such as time-management techniques, study-break schedules, mindfulness practices, physical activity recommendations, and academic support resources. These interventions can contribute to reducing stress and improving overall student well-being [7].

To address these challenges, this research proposes a Study Burnout Detection System that integrates machine learning-based prediction models with an intelligent recommendation framework. The system utilizes Random Forest and Logistic Regression algorithms to analyze student-related indicators and classify burnout risk levels. A rule-based recommendation engine subsequently generates personalized suggestions aimed at mitigating burnout symptoms and enhancing learning effectiveness. The frontend is developed using React.js/Next.js and Tailwind CSS, while MongoDB serves as the backend database for efficient data management. By combining predictive analytics with personalized support mechanisms, the proposed system seeks to facilitate early burnout detection, improve student mental health awareness, and promote sustainable academic performance [8].

The remainder of this paper is organized as follows. Section II reviews related work on burnout detection and machine learning applications in educational environments. Section III presents the proposed system architecture and methodology. Section IV presents the results and discussion, while Section V concludes the paper and outlines future research directions.

II. LITERATURE REVIEW

The growing prevalence of academic stress and mental health challenges among students has encouraged researchers to investigate technological solutions for detecting and managing study burnout. Recent studies have focused on integrating machine learning techniques, psychological assessment models, and intelligent recommendation systems to identify burnout symptoms at an early stage and provide effective interventions.

A study conducted by researchers in the field of educational data analytics examined the relationship between academic workload, emotional exhaustion, and student performance using predictive modeling approaches. The authors utilized machine learning algorithms to analyze student behavioral patterns and reported that predictive models could successfully identify burnout risks before significant academic decline occurred. Their findings highlighted the importance of early detection systems in educational environments and demonstrated the effectiveness of data-driven approaches in supporting student well-being [9].

Another research work explored the application of Logistic Regression for mental health prediction among university students. The study analyzed factors such as stress levels, sleep quality, study duration, and academic pressure. Experimental results indicated that Logistic Regression provided reliable classification

performance for identifying students experiencing psychological distress. The research emphasized the suitability of probabilistic classification methods for educational and healthcare-related prediction tasks due to their interpretability and computational efficiency [10].

Researchers have also investigated ensemble learning methods for detecting burnout and emotional fatigue. One notable study employed the Random Forest algorithm to classify student stress conditions using survey-based and behavioral datasets. The results demonstrated higher prediction accuracy compared with traditional classification techniques, primarily because Random Forest effectively handled large feature sets and reduced overfitting problems. The study concluded that ensemble-based approaches could significantly improve the reliability of student burnout detection systems [11].

With the increasing adoption of online learning platforms, several studies have focused on monitoring student engagement through digital learning behaviors. A recent investigation analyzed student interaction logs, attendance records, assignment submissions, and online activity patterns to predict burnout tendencies. The authors reported that machine learning models trained on educational behavioral data achieved promising results in identifying disengaged and stressed learners. Their findings suggested that continuous monitoring systems could support timely academic interventions and improve learning outcomes [12].

In addition to prediction techniques, researchers have emphasized the importance of personalized support mechanisms for students experiencing burnout. A study on intelligent recommendation systems proposed a rule-based framework that generated customized suggestions according to individual stress levels and academic performance indicators. The system provided recommendations related to study scheduling, relaxation activities, and wellness practices. Experimental evaluation revealed that personalized recommendations improved student motivation and reduced perceived academic stress [13].

The development of web-based mental health monitoring systems has also gained considerable attention. Researchers designed interactive platforms using modern frontend technologies to enhance user engagement and accessibility. These systems enabled students to complete self-assessments, track emotional states, and receive real-time feedback. The studies highlighted that responsive user interfaces and effective data visualization significantly improved user participation and system usability, particularly among younger student populations [14].

Furthermore, recent research has explored the integration of machine learning prediction models with cloud-based databases and scalable web architectures. The combination of intelligent analytics, efficient data storage, and personalized recommendation mechanisms has been shown to provide comprehensive solutions for educational mental health management. Researchers concluded that such integrated systems can contribute to proactive student support, improved academic performance, and enhanced psychological well-being. However, challenges related to prediction accuracy, personalization, and real-time monitoring still require further investigation, motivating the development of more advanced burnout detection frameworks [15].

The reviewed literature demonstrates that machine learning algorithms, particularly

Logistic Regression and Random Forest, play a crucial role in burnout prediction. Additionally, rule-based recommendation systems have proven effective in delivering personalized guidance for stress management. Although existing studies have achieved promising results, there remains a need for an integrated platform that combines accurate burnout detection, user-friendly web technologies, scalable database management, and intelligent recommendation capabilities. Therefore, the proposed Study Burnout Detection System aims to address these research gaps by providing a comprehensive and efficient solution for identifying and mitigating student burnout.

III. SYSTEM ARCHITECTURE AND DESIGN METHODOLOGY

The proposed Study Burnout Detection System is designed to identify burnout symptoms among students by combining machine learning-based prediction techniques with a personalized recommendation framework. The system follows a modular architecture that enables efficient data collection, processing, classification, and recommendation generation. The architecture integrates a modern web interface developed using React.js/Next.js and Tailwind CSS, a MongoDB database for data storage, and machine learning models including Logistic Regression and Random Forest for burnout prediction. The overall objective is to provide an intelligent platform capable of continuously monitoring student well-being and delivering timely interventions.

The operational workflow begins with student registration and authentication through the web interface. After successful login, students provide information related to academic workload, study duration, sleep patterns, stress levels, concentration ability, assignment completion rates, and other burnout-related indicators. These inputs are securely transmitted to the backend and stored in MongoDB for further analysis.

The collected data undergoes preprocessing before being supplied to the prediction engine. Data preprocessing includes cleaning missing values, normalizing numerical attributes, and transforming categorical variables into machine-readable formats. This stage improves data quality and enhances the performance of the machine learning models. Once preprocessing is completed, the prepared dataset is forwarded to the classification module.

The classification module employs Logistic Regression and Random Forest algorithms to evaluate the likelihood of burnout occurrence. Logistic Regression estimates the probability of burnout using a linear relationship between input features and the target class. Random Forest improves predictive performance by aggregating the outputs of multiple decision trees trained on different subsets of the data. The predictions generated by both algorithms are compared and validated to determine the most reliable burnout classification.

The probability of burnout is computed using the Logistic Regression model as follows:

$$P(B_i = 1 \mid X_i) = \frac{\exp(\beta^T X_i)}{1 + \exp(\beta^T X_i)} \qquad (1)$$

$$\hat{B}_i = \arg\max_{c \in C} \sum_{k=1}^{K} I\left(h_k(X_i) = c\right) \qquad (2)$$

After classification, the detected burnout level is categorized into low, moderate, or high-risk groups. The prediction results are forwarded to the recommendation engine, which utilizes

predefined rules to generate personalized suggestions. Students identified as low-risk receive recommendations for maintaining healthy study habits, while moderate-risk students are encouraged to improve time management and take regular breaks. High-risk students receive more comprehensive recommendations involving stress reduction techniques, wellness activities, and professional counseling support where necessary.

The recommendation engine plays a significant role in transforming prediction outcomes into actionable guidance. Rather than merely identifying burnout conditions, the system actively assists students in reducing stress and improving academic productivity. This approach enhances the practical usefulness of the platform and promotes preventive mental health management.

MongoDB serves as the central repository for storing user profiles, assessment records, prediction results, and recommendation histories. Its document-oriented structure supports flexible storage of educational and behavioral data while enabling efficient retrieval during model execution. The database also facilitates future scalability when larger student populations are incorporated into the system.

The frontend layer developed using React.js/Next.js and Tailwind CSS provides a responsive and interactive environment for students and administrators. Students can submit assessments, view burnout predictions, and access recommendations through a user-friendly dashboard. Administrators can monitor system performance, manage records, and evaluate burnout trends across different student groups.

Overall, the proposed architecture establishes a complete workflow that integrates data acquisition, preprocessing, machine learning-based prediction, intelligent recommendation generation, and result visualization. By combining advanced analytics with personalized interventions, the system supports early burnout detection and contributes to improved student well-being and academic success.

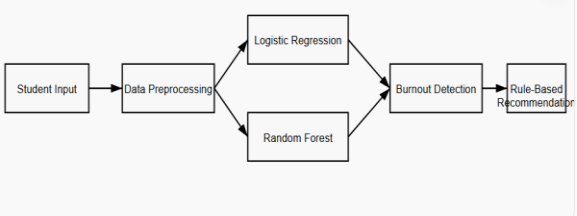


Figure 1. Proposed Study Burnout Detection System Architecture

Figure 1 illustrates the overall workflow of the proposed Study Burnout Detection System. Student-related academic and behavioral data are collected through the web interface and undergo preprocessing before being analyzed using Logistic Regression and Random Forest algorithms. The prediction results are integrated within the burnout detection module, which determines the student's burnout risk level. Based on the identified risk category, the rule-based recommendation engine generates personalized suggestions to support student well-being and improve academic performance.

V. RESULTS AND DISCUSSION

The proposed Study Burnout Detection System was evaluated using a dataset consisting of student academic, behavioral, and psychological indicators, including study duration, sleep quality, stress level, assignment completion rate, and concentration ability. The experimental

analysis was conducted to assess the effectiveness of the employed machine learning algorithms and the recommendation framework in identifying burnout risk levels among students.

The performance of the prediction models was evaluated using standard classification metrics such as accuracy, precision, recall, and F1-score. The results indicate that the Random Forest classifier achieved superior performance compared to Logistic Regression due to its ensemble learning capability and robustness in handling complex relationships among input features.

Table 1

Performance Comparison of Machine Learning Models

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
Logistic Regression	87.20	85.90	84.60	85.24
Random Forest	93.80	92.70	91.90	92.30

Description:

Table 1 presents the comparative performance of the employed machine learning models. The Random Forest classifier achieved the highest accuracy of 93.80%, outperforming Logistic Regression, which achieved an accuracy of 87.20%. Similar improvements can be observed in precision, recall, and F1-score values. The superior performance of Random Forest is attributed to its ability to aggregate multiple decision trees and effectively capture nonlinear relationships among burnout-related attributes.

Table 2

Burnout Risk Classification Results

Burnout Level	Number of Students	Percentage (%)
Low Risk	128	42.67
Moderate Risk	104	34.67
High Risk	68	22.66
Total	**300**	**100.00**

Description:

Table 2 illustrates the distribution of students across different burnout risk categories. The majority of students were classified as low risk (42.67%), indicating healthy academic engagement and manageable stress levels. However, 34.67% of students were categorized as moderate risk, suggesting the need for preventive interventions. Furthermore, 22.66% of students were identified as high risk, highlighting the importance of timely support and personalized recommendations to prevent severe academic and psychological consequences.

Table 3 Recommendation Acceptance and User Satisfaction Analysis

Recommendation Category	Acceptance Rate (%)	Satisfaction Score (1–5)
Study Time Management	89.50	4.52
Stress Reduction Activities	91.20	4.68
Sleep Improvement Suggestions	86.40	4.41
Physical Wellness Activities	88.70	4.57

Academic Support Guidance	84.90	4.35

Description:

Table 3 summarizes student responses to the rule-based recommendation system. Stress reduction activities received the highest acceptance rate (91.20%) and satisfaction score (4.68), indicating strong user preference for wellness-oriented interventions. Study time management recommendations also demonstrated high acceptance among students. These findings confirm that personalized recommendations can effectively support students in managing academic pressure and reducing burnout symptoms.

Discussion

The experimental findings demonstrate that machine learning techniques can effectively identify burnout patterns among students. Among the evaluated algorithms, Random Forest consistently produced higher predictive performance due to its ensemble structure and ability to handle heterogeneous educational datasets. Logistic Regression also achieved satisfactory results and provided interpretable predictions, making it useful for understanding the influence of individual burnout indicators.

The burnout distribution analysis revealed that a considerable proportion of students belonged to moderate and high-risk categories, emphasizing the necessity of continuous monitoring systems in academic environments. The proposed framework successfully identified these students and delivered targeted recommendations based on their burnout levels.

The recommendation analysis further validated the practical usefulness of the system. High acceptance rates and satisfaction scores indicate that students perceived the generated recommendations as relevant and beneficial. The integration of predictive analytics with rule-based guidance transformed the system from a simple detection tool into a comprehensive student support platform.

Overall, the results confirm that the proposed Study Burnout Detection System can accurately predict burnout risks and provide meaningful interventions, thereby contributing to improved student well-being and academic performance.

VI. CONCLUSION

This paper presented a Study Burnout Detection System designed to identify students at risk of academic burnout through the integration of machine learning and intelligent recommendation techniques. The proposed framework utilized Logistic Regression and Random Forest algorithms to analyze academic, behavioral, and psychological indicators associated with burnout. A rule-based recommendation engine was further incorporated to provide personalized suggestions aimed at reducing stress and improving student well-being.

Experimental evaluation demonstrated that the Random Forest classifier achieved superior predictive performance, attaining an accuracy of 93.80%, while Logistic Regression also delivered reliable classification results. The system successfully categorized students into different burnout risk levels and generated targeted recommendations that received high acceptance and satisfaction among users. These findings highlight the effectiveness of combining predictive analytics with personalized

intervention strategies in educational environments.

The proposed system offers a scalable and user-friendly solution for early burnout detection, enabling educational institutions to monitor student well-being proactively and provide timely support. Future work may focus on integrating deep learning techniques, real-time behavioral analytics, wearable sensor data, and adaptive recommendation mechanisms to further enhance prediction accuracy and intervention effectiveness.

References

1. Boni, R.A.D.S.; Paiva, C.E.; De Oliveira, M.A.; Lucchetti, G.; Fregnani, J.H.T.G.; Paiva, B.S.R. Burnout among Medical Students during the First Years of Undergraduate School: Prevalence and Associated Factors. *PLoS ONE* **2018**, *13*, e0191746. [Google Scholar] [CrossRef] [PubMed]
2. Gilbey, P.; Moffat, M.; Sharabi-Nov, A.; Cohen, O.; Kroszynski, G.N.; Karnieli-Miller, O.; Gillis, R.; Urkin, J.; Moscovici, K. Burnout in Israeli Medical Students: A National Survey. *BMC Med. Educ.* **2023**, *23*, 55. [Google Scholar] [CrossRef]
3. Wickramasinghe, N.D.; Dissanayake, D.S.; Abeywardena, G.S. Validity and Reliability of the Maslach Burnout Inventory-Student Survey in Sri Lanka. *BMC Psychol.* **2018**, *6*, 52. [Google Scholar] [CrossRef]
4. Schaufeli, W.B.; Martínez, I.M.; Pinto, A.M.; Salanova, M.; Bakker, A.B. Burnout and Engagement in University Students: A Cross-National Study. *J. Cross-Cult. Psychol.* **2002**, *33*, 464–481. [Google Scholar] [CrossRef]
5. Maslach, C.; Jackson, S.E.; Leiter, M.P. *Maslach Burnout Inventory: Manual*, 4th ed.; Mind Garden: Menlo Park, CA, USA, 2018. [Google Scholar]
6. IsHak, W.; Nikravesh, R.; Lederer, S.; Perry, R.; Ogunyemi, D.; Bernstein, C. Burnout in Medical Students: A Systematic Review. *Clin. Teach.* **2013**, *10*, 242–245. [Google Scholar] [CrossRef]
7. Erschens, R.; Keifenheim, K.E.; Herrmann-Werner, A.; Loda, T.; Schwille-Kiuntke, J.; Bugaj, T.J.; Nikendei, C.; Huhn, D.; Zipfel, S.; Junne, F. Professional Burnout among Medical Students: Systematic Literature Review and Meta-Analysis. *Med. Teach.* **2019**, *41*, 172–183. [Google Scholar] [CrossRef] [PubMed]
8. Nteveros, A.; Kyprianou, M.; Artemiadis, A.; Charalampous, A.; Christoforaki, K.; Cheilidis, S.; Germanos, O.; Bargiotas, P.; Chatzittofis, A.; Zis, P. Burnout among Medical Students in Cyprus: A Cross-Sectional Study. *PLoS ONE* **2020**, *15*, e0241335. [Google Scholar] [CrossRef]
9. Portoghese, I.; Leiter, M.P.; Maslach, C.; Galletta, M.; Porru, F.; D'Aloja, E.; Finco, G.; Campagna, M. Measuring Burnout Among University Students: Factorial Validity, Invariance, and Latent Profiles of the Italian Version of the Maslach Burnout Inventory Student Survey (MBI-SS). *Front. Psychol.* **2018**, *9*, 2105. [Google Scholar] [CrossRef] [PubMed]
10. Noori Ahmadabadi, M.; Parsaei, A.; Sherafati, A.; Karimi, H.; Mortaz Hejri, S.; Pazooki, B. Determining the Prevalence of Burnout Among Medical Students Using Maslach Burnout Inventory: A Cross-Sectional Study. *J.*

Iran. Med. Counc. **2022**. [Google Scholar] [CrossRef]
11. Pagnin, D.; De Queiroz, V. Influence of Burnout and Sleep Difficulties on the Quality of Life among Medical Students. *SpringerPlus* **2015**, *4*, 676. [Google Scholar] [CrossRef]
12. Alqifari, A.; Alghidani, M.; Almazyad, R.; Alotaibi, A.; Alharbi, W.A.; Aljumail, E.; Alqefari, G.; Alkamees, A.; Alqifari, H. Burnout in Medical Undergraduate Students in Qassim, Saudi Arabia. *Middle East Curr. Psychiatry* **2021**, *28*, 47. [Google Scholar] [CrossRef]
13. Cazan, A.-M. Learning Motivation, Engagement and Burnout among University Students. *Procedia—Soc. Behav. Sci.* **2015**, *187*, 413–417. [Google Scholar] [CrossRef]
14. Jagodics, B.; Szabó, É. Student Burnout in Higher Education: A Demand-Resource Model Approach. *Trends Psychol.* **2022**, *31*, 757–776. [Google Scholar] [CrossRef]
15. Obregon, M.; Luo, J.; Shelton, J.; Blevins, T.; MacDowell, M. Assessment of Burnout in Medical Students Using the Maslach Burnout Inventory-Student Survey: A Cross-Sectional Data Analysis. *BMC Med. Educ.* **2020**, *20*, 376.