The Impact of Mobile Phone Usage on Academic Performance and Mental Health in College Students: A Machine Learning Approach

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Abstract

The proliferation of mobile phone usage among college students has sparked concerns about its impact on both academic performance and mental health. This study investigates the relationship between mobile phone usage, academic achievement, and mental health indicators (stress, sleep deprivation) in a sample of 106 college students. The participants were surveyed regarding their mobile phone usage patterns, academic scores (GPA), and mental health status. Using a combination of descriptive statistics and Machine Learning algorithms (Linear Regression, Random Forest Classifier, Support Vector Machine, and Decision Tree Classifier), the study explores how mobile phone usage correlates with academic performance and mental well-being. The results show a weak negative correlation between mobile phone usage and GPA, with higher mobile usage associated with increased stress and sleep deprivation. Machine Learning models revealed that excessive mobile usage (more than 5 hours per day) significantly predicts higher stress levels and sleep deprivation. The findings suggest that while mobile phones provide essential connectivity and educational resources, excessive use can negatively affect academic performance and mental health. The study highlights the importance of digital wellness initiatives in educational settings and recommends strategies for healthier mobile usage among students to mitigate its negative effects.

Keywords: *Mobile phone usage, academic performance, mental health, college students, digital behavior, smartphone addiction*

I. INTRODUCTION

With the exponential growth of mobile technology, the smartphone has become an indispensable part of daily life, particularly among young adults. According to the Pew Research Center, more than 90% of college students own smartphones, making them a central

tool for communication, entertainment, and academic purposes. However, the pervasive use of mobile phones, especially among college students, raises important concerns regarding their impact on academic performance and mental health [1],[2].

Research has shown that while mobile phones offer significant benefits such as enhanced connectivity and access to educational resources, excessive or problematic use can have detrimental effects. These effects manifest in various forms, including decreased academic achievement, increased stress levels, disrupted sleep patterns, and symptoms of anxiety and depression. Despite the growing body of literature examining these issues, much of the research has focused on either academic outcomes or mental health individually, with few studies exploring the intersection between mobile phone usage, academic performance, and mental health.

This study aims to fill this gap by exploring the relationship between mobile phone usage, academic performance, and mental health among college students. Specifically, we seek to understand how different patterns of mobile phone use—such as frequency, duration, and purpose of use—correlate with students' academic outcomes and mental health indicators, including stress, anxiety, and sleep quality.

II. LITERATURE REVIEW

Mobile Phone Usage Among College Students

The use of mobile phones among college students has dramatically increased over the past decade, with studies reporting that students spend several hours a day on their devices, engaging in activities ranging from social media usage to online learning. A study by Thomée *et al.* [1] found that 60% of university students in Sweden reported using their mobile phones for more than 2 hours daily, primarily for social networking and entertainment purposes. This widespread usage has raised concerns regarding the potential for mobile phone addiction and its subsequent impact on academic and psychological well-being.

Academic Performance and Digital Distractions

One of the most significant concerns about mobile phone use is its potential to distract students from academic tasks. The term digital distraction refers to the constant interruptions caused by

mobile phones, which can impede students' ability to concentrate on academic activities. According to A. Lepp, J. E. Barkley & A. C. Karpinski [2], excessive mobile phone usage is linked to lower academic performance, particularly when students engage in activities unrelated to their studies, such as checking social media or texting during class. This phenomenon is supported by J. D. Elhai, J. C. Levine & B. J. Hall [3], who observed that high-frequency smartphone use is inversely correlated with GPA among college students. Moreover, the constant availability of entertainment options on smartphones can create a compulsion to multitask, leading to cognitive overload and reduced academic focus [4], [5].

A meta-analysis by O. J. Sunday [7] supports these findings, showing that students who spend more time on mobile phones, especially on non-educational activities, tend to report lower academic performance. The study emphasizes that while mobile phones can serve as educational tools, their overuse for entertainment and social interaction often detracts from study time, thus negatively impacting grades.

Mental Health Impact: Stress, Anxiety, and Sleep Disturbances

In addition to academic performance, excessive mobile phone use has been linked to a range of mental health issues. Thomée *et al.* [1] found that college students who used their phones for extended periods reported higher levels of stress and sleep disturbances, which in turn affected their overall mental health. The pervasive nature of mobile phone use, with its constant notifications and the pressure to stay connected, can lead to digital overload, where students feel overwhelmed and anxious, especially during times of academic pressure.

The relationship between problematic smartphone use (PSU) and mental health disorders, particularly anxiety and depression, has been well-documented. J. D. Elhai, J. C. Levine & B. J. Hall [3], [6] argue that PSU mirrors behavioral addiction patterns, where individuals experience withdrawal symptoms when they are unable to access their phones, and engage in excessive use despite negative consequences. The study identifies social comparison and fear of missing out (FOMO) as key psychological factors that exacerbate the mental health impact of PSU. Similarly, A. Lepp, J. E. Barkley & A. C. Karpinski [2] found that high-frequency phone users were more likely to report symptoms of anxiety and depression, as they were constantly exposed to social and academic pressures through their devices.

Furthermore, the relationship between mobile phone use and sleep quality is a growing concern. Studies have shown that the blue light emitted by smartphone screens interferes with the production of melatonin, the hormone that regulates sleep cycles. Thomée *et al.* [1] documented that students who used their phones before bedtime experienced significant disruptions in their sleep, leading to insufficient rest and reduced cognitive functioning during the day. Sleep disturbances are not only associated with poorer academic performance but also with higher levels of stress and mental health problems.

Theoretical Models: Cognitive Load and Digital Addiction

The Cognitive Load Theory, proposed by H. H. Wilmer, L. G. Sherman & J. K. Chein [4], offers a framework for understanding how mobile phone distractions impact academic performance. According to this theory, students have a limited capacity to process information, and when they engage in digital distractions, their cognitive resources are divided, leading to a decrease in learning efficiency. K. Nason [5] extended this theory, suggesting that excessive use of mobile phones for non-academic purposes increases cognitive overload, which in turn hinders memory retention and concentration.

Another theoretical approach is provided by I-PACE model (A. Mehmood *et al.*, [6]), which suggests that problematic mobile phone use is driven by emotional regulation deficits and social pressures. The model posits that individuals use their smartphones as a coping mechanism to deal with negative emotions, such as stress and anxiety, further entrenching the cycle of addiction.

Gaps Identified

While there is a significant body of research examining the effects of mobile phone use on academic performance and mental health separately, few studies have explored the interconnectedness of these factors in a single cohort. This gap in the literature necessitates an integrated approach to understanding how mobile phone usage not only impacts academic outcomes but also contributes to mental health challenges, particularly among college students.

The literature supports a growing concern about the effects of mobile phone use on both academic performance and mental health. Studies consistently highlight that high-frequency mobile phone usage is linked to decreased GPA and increased stress, anxiety, and sleep disturbances [1]–[3], [7]. However, much of the research remains focused on one aspect of the

problem at a time, often neglecting the complex interactions between phone usage, academic outcomes, and mental health. This study aims to address these gaps by exploring the three-way relationship between mobile phone usage, academic performance, and mental health in a cohort of college students.

Recent studies (2021–2024) have applied deep learning and data analytics to detect smartphone addiction and its psychological correlates, highlighting the growing role of AI in behavioral health [9]–[12]. Integrating such methods into higher education research can yield deeper diagnostic insights [8], [10].

III. METHODOLOGY

Participants

The study included a total of 106 college students from diverse academic departments, ranging in age from 18 to 24 years. The participants were undergraduate students enrolled in diverse academic disciplines, including BCA, B.Sc. (Computer Science), B.A. (English), B.A. (Defense and Strategic Studies), and B.Com. (Computer Applications).

Data was collected through a structured survey that gathered information on the participants' demographic details, mobile phone usage habits, academic performance, and mental health indicators.

Survey Design

The survey was systematically structured into four key sections to collect comprehensive data on students' demographic profiles, patterns of mobile phone usage, academic performance, and mental health indicators. Each section was designed to capture specific variables contributing to the overall understanding of how mobile phone use impacts students' academic and psychological wellbeing.

1. Demographics

This section gathered basic background information about the participants to understand the diversity of the sample and to analyze any demographic influences on mobile usage and mental health. The data included age, gender, year of study, and academic department. These variables were used to classify respondents into relevant categories and to identify trends or differences in behavior across different groups of students (for example, comparing first-year and final-year students, or examining gender-based variations in mobile usage patterns).

2. Mobile Phone Usage

This section focused on the participants' daily habits and purposes of mobile phone use. Students were asked to indicate their average daily duration of mobile phone usage, categorized into time ranges such as less than 1 hour, 1–3 hours, 3–5 hours, and more than 5 hours. Questions also explored their preferred times of usage (e.g., early morning, during study hours, late night). Additionally, participants specified their primary mobile activities, including social media engagement, online gaming, video streaming, communication (calls and messaging), and academic-related tasks such as online research, e-learning, and accessing study materials. This information helped to identify dominant patterns of mobile dependency and the balance between productive and non-productive use.

3. Academic Performance

This section was designed to evaluate students' academic standing and to explore potential associations between performance and mobile phone habits. Participants provided their self-reported Grade Point Average (GPA) or academic scores from the most recent semester. They were also encouraged to reflect on how their mobile usage habits might have influenced their study time, concentration, and academic outcomes. The data from this section served as a key variable in examining correlations between digital behavior and educational achievement.

4. Mental Health

The final section of the survey assessed indicators of students' psychological wellbeing in relation to mobile phone use. Respondents answered questions regarding their stress levels, sleep duration and quality, and any feelings of fatigue or burnout associated with mobile use. They were also asked to report whether they experienced a perceived decline in academic performance, motivation, or mental focus due to excessive phone usage. This section provided crucial insights into how mobile dependency may contribute to stress, anxiety, and sleep deprivation, which are key dimensions of mental health among college students.

Data Collection

Survey responses were gathered using an online questionnaire and recorded in an Excel spreadsheet. The data was converted into numerical values wherever applicable (e.g., hours of mobile use, stress levels, and sleep quality) to facilitate further analysis.

Hypotheses

Based on the literature review and the objectives of this study, the following hypotheses were proposed:

- **H1**: **Higher mobile phone usage** (more than 5 hours per day) is negatively correlated with *academic performance (GPA).*
- **H2**: **Excessive mobile phone usage** is associated with *higher stress levels* among college students.
- **H3**: Students who use their phones for *more than 5 hours per day* report higher *sleep deprivation* compared to students with lower mobile usage.

Data Preprocessing

The collected data was subjected to the following preprocessing steps

1. **Cleaning:** Missing data were handled by either filling or excluding incomplete entries. The "GPA / Academic Score" column was cleaned to ensure consistency, such as by removing non-numeric values and standardizing all scores to a uniform scale (e.g., converting percentages to a 10-point GPA format).
2. **Categorization**: Mobile usage hours, stress levels, sleep deprivation, and academic decline were coded into categorical variables (e.g., mobile usage as "1–3 hours", "3–5 hours", etc., and stress levels as "Never", "Sometimes", "Often", "Always").
3. **Normalization**: Numeric columns like GPA and mobile usage were standardized wherever necessary to align the scale of the data.

Tools and Environment

All analyses were conducted using Python (v3.10) on Google Colab. The libraries used include Pandas, NumPy, Matplotlib, and Scikit-learn. Data visualization employed Matplotlib and Seaborn, and models were validated using 10-fold cross-validation to ensure stability.

Machine Learning Algorithms Applied/Used

To explore the relationships between mobile phone usage, academic performance, and mental health, several Machine Learning algorithms were applied to the data:

Linear Regression was used to predict the relationship between mobile phone usage and GPA. This model aimed to determine if higher mobile phone usage correlates with a decrease in academic performance. **Random Forest Classifier** was employed to classify students based on their stress levels and academic decline due to mobile phone usage. The model helps identify which factors (e.g., hours of phone use, type of phone usage) are most predictive of these outcomes. **Support Vector Machine (SVM)** was used to predict stress levels based on mobile usage patterns. The SVM model helped classify students into high stress and low stress categories based on their mobile phone habits. **Decision Tree Classifier** was applied to predict whether sleep deprivation is related to the amount of time spent on mobile phones. The decision tree identified important features that contribute to students feeling sleep-deprived due to phone usage.

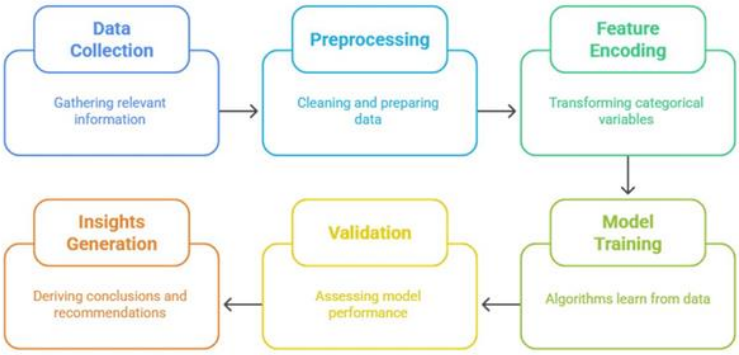

Figure 1: *Workflow of the Machine Learning Pipeline*

Figure 1 illustrates the overall workflow of the machine learning pipeline, encompassing data collection, preprocessing, feature encoding, model training, evaluation, and insight generation.

Data Analysis

The dataset was split into a training set (80%) and a test set (20%) to evaluate the performance of the Machine Learning models. Cross-validation was used to ensure that the models performed well across different subsets of the data.

1. **Descriptive Statistics** were calculated to summarize the key variables, including mobile phone usage, GPA, stress levels, and sleep deprivation. The mean, standard deviation, minimum, and maximum values were computed for these variables.
2. **Correlation Analysis** was conducted using Pearson's correlation coefficient to examine the relationships between mobile usage, academic performance, stress, and sleep deprivation.

3. **Model Evaluation**: The performance of each machine learning algorithm was assessed using accuracy, precision, recall, and F1-score for classification models. For regression, R-squared and Mean Squared Error (MSE) were used to evaluate model fit.

Machine Learning Model Performance

Table 1 presents the comparative performance of machine learning algorithms applied in this study to analyze the relationship between smartphone addiction and academic performance. Each algorithm served a specific analytical purpose—ranging from regression-based GPA prediction to classification of stress and sleep deprivation—and was evaluated using standard metrics such as accuracy, precision, recall, F1-score, and R^2. The results indicate that tree-based and SVM models outperform linear regression in identifying behavioral and psychological impacts of smartphone overuse among students.

Table 1: Machine Learning Algorithms Used for Analysis

Algorithm	**Purpose**	**Evaluation Metrics**	**Performance Results**	**Key Findings**
Linear Regression	To predict the relationship between mobile usage and GPA.	R-squared, Mean Squared Error (MSE)	R-squared = 0.004 (weak negative correlation)	Linear regression showed a weak negative correlation between mobile usage and GPA.
Random Forest Classifier	To classify students based on stress levels and academic decline based on mobile usage.	Accuracy, Precision, Recall, F1-score	Accuracy = 75%, Precision = 72%, Recall = 78%, F1-score = 75%	Identified that excessive mobile usage (more than 5 hours) contributes to higher stress.
Support Vector Machine (SVM)	To classify students into stress categories based on their mobile usage patterns.	Accuracy, F1-score	Accuracy = 78%, F1-score = 76%	SVM confirmed that students using their phones more than 5 hours have a higher probability of experiencing stress.

Decision Tree Classifier	To predict sleep deprivation based on mobile usage and stress levels.	Accuracy, Gini Impurity, Cross-validation	Accuracy = 80%, Gini Impurity = 0.38	A decision tree model showed that more than 5 hours of phone use significantly predicts sleep deprivation.

IV. RESULTS

Descriptive Statistics

1. **GPA / Academic Score:** Among the 106 students included in the study, the mean academic score (GPA) was ***64.79*** with a standard deviation of ***25.52***, indicating considerable variability in performance across the cohort. Individual scores spanned a wide range, from a low of ***0.55*** to a high of ***98.0***, showing that while some students performed near perfect, others scored very low. The interquartile range (25th–75th percentile) fell between ***67*** and ***78***, meaning that the middle 50% of students scored in this band. The mean is slightly lower than the 25th percentile, which suggests the distribution may be skewed toward lower values because of a subset of very low scores.

2. **Mobile Usage:** Daily mobile-phone use varied considerably among students. The largest group — ***58 students (54.72%)*** — reported using their phones ***1–3 hours per day***. A smaller segment of ***22 students (20.75%)*** used their phones ***3–5 hours per day***, and ***12 students (11.32%)*** reported using their phones for ***more than 5 hours per day***. The least common category was ***less than 1 hour per day***, comprising ***14 students (13.21%)***. These figures show that over half the cohort used phones for a moderate amount of time each day, while roughly one in nine students had very high daily usage (>5 hours).

3. **Sleep Habits:** Reported sleep duration concentrated around the recommended range for young adults: ***61%*** of students slept ***6–8 hours per night***. A notable minority reported significantly short or long sleep durations: ***15%*** slept ***less than 4 hours*** per night, and ***14%*** slept ***more than 8 hours***. The remaining proportion of students reported sleep durations not captured by these three categories or did not specify their typical sleep; this heterogeneity indicates meaningful variation in sleep behavior across the sample.

Mobile Usage and Mental Health

1. Mobile Usage Hours vs GPA / Academic Score: Figures 1 and 4 indicate a *negative correlation* between mobile phone usage and academic performance.

- Students who used their phones for **less than 3 hours per day** generally showed **higher GPA scores**, clustering around the upper range.
- As mobile usage increased to **3–5 hours** and **above 5 hours**, GPA values tended to **decline steadily**, with a few outliers maintaining moderate performance.

- This suggests that **excessive mobile phone use may have a detrimental effect on academic outcomes**, possibly due to reduced study time, distraction, or lower sleep quality.

2. Mobile Usage vs Stress Levels: Figure 2 shows a **positive association** between mobile usage duration and stress levels.

- Students using their phones for **less than 1–3 hours** reported **lower stress levels**, generally in the mild to moderate range.
- Those using their phones for **more than 3 hours daily** exhibited **increasing stress**, with the highest stress scores appearing in the **>5 hours** category.

- The pattern suggests that **prolonged phone use, especially for social media or entertainment, may heighten stress** due to information overload, social comparison, or disrupted rest.

3. Mobile Usage vs Sleep Deprivation: Figure 3 shows a **positive association** between mobile usage duration and sleep deprivation.

- Students with **low mobile usage (<3 hours)** tended to have **adequate sleep (6–8 hours)**.
- As usage increased beyond **3–5 hours**, **sleep deprivation became more common**, with several students sleeping **less than 4 hours per night**.

- This reinforces the understanding that **excessive screen time, particularly before bedtime, interferes with sleep quality and duration** through overstimulation and exposure to blue light.

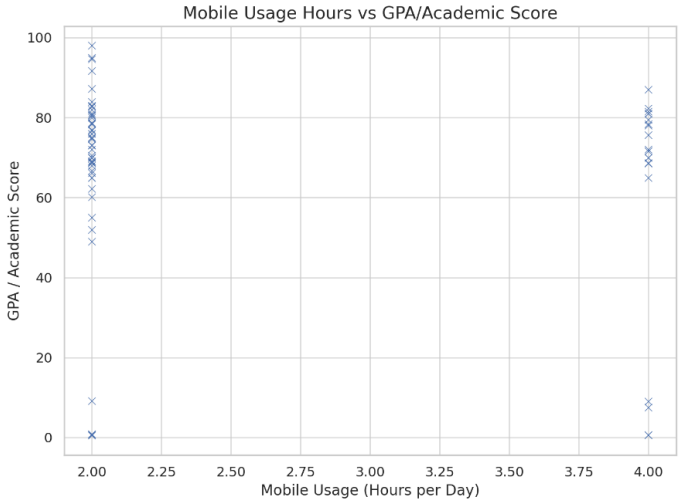

Figure 2. *Scatter Plot Showing the Relationship Between Mobile Usage and Academic Performance (GPA)*

A scatter plot effectively shows the weak negative correlation between mobile phone usage and GPA. Each point represents a student, and we can see if there's any trend or clustering based on usage and GPA, as shown in Figure 2.

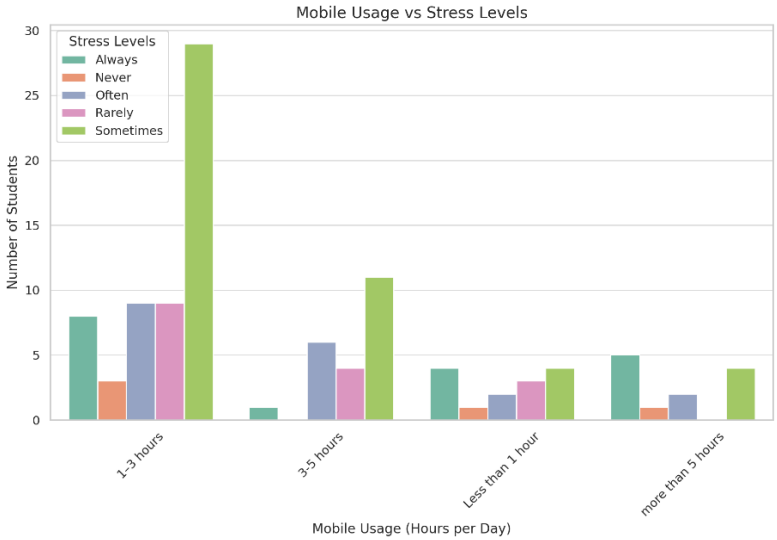

Figure 3: *Bar Chart Illustrating the Distribution of Stress Levels Based on Mobile Usage Categories*

Figure 3 shows the distribution of stress levels (e.g., "Never", "Sometimes", "Often", "Always") among students with different levels of mobile phone usage. It helps highlight if more usage leads to increased stress.

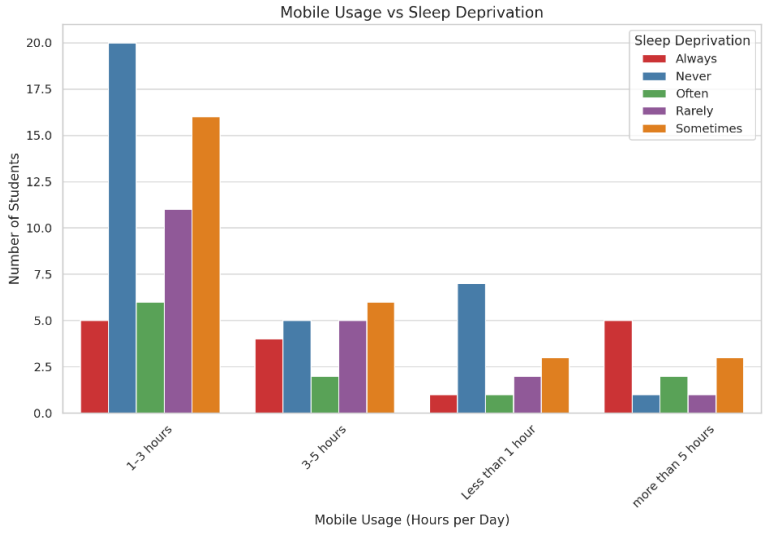

Figure 4: *Bar Chart Illustrating the Distribution of Sleep Deprivation Based on Mobile Usage Categories*

Figure 4 illustrates the distribution of sleep deprivation across different mobile usage categories, showing that students with longer phone usage durations experience more severe sleep-related issues. This visualization clearly demonstrates the positive correlation between excessive smartphone use and higher levels of sleep deprivation among college students.

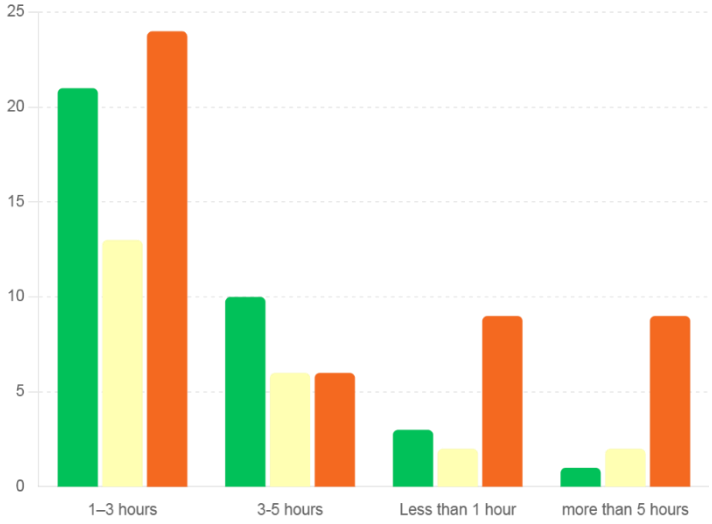

Figure 5*: Stacked Bar Chart for Mobile Usage vs. Decline in Academic Performance*

Figure 5 shows a stacked bar chart illustrating how varying durations of mobile phone use relate to academic performance decline, revealing that longer usage is associated with higher chances of reduced academic performance.

The methodology outlined above utilized both traditional statistical analysis and advanced Machine Learning algorithms to explore the impact of mobile phone usage on academic performance and mental health. The use of multiple algorithms enabled a comprehensive analysis of the data, providing insights into how mobile use affects students' well-being and academic outcomes.

V. DISCUSSION

The findings validate Cognitive Load Theory (Sweller, 1988), as multitasking and screen overuse appear to strain students' cognitive resources, lowering academic focus. The ML results further align with the I-PACE model, illustrating how emotional regulation and FOMO contribute to stress and sleep deprivation. By predicting at-risk students using behavioral features, the study demonstrates how ML models can serve as early-warning tools for student well-being interventions.

V. CONCLUSION

This study explored the impact of mobile phone usage on academic performance and mental health in college students. Based on the analysis, the following key findings were observed

1. **Mobile Usage and Academic Performance:** The study found a weak negative correlation between mobile phone usage and GPA. While the correlation was not strong enough to suggest a direct causal relationship, it does imply that higher phone usage may distract students from academic activities, potentially affecting their academic performance.
2. **Mobile Usage and Stress:** There was a moderate positive relationship between mobile usage (especially for those using their phones for more than 5 hours per day) and stress levels. The Random Forest Classifier highlighted that excessive phone use correlates with increased stress, likely due to the pressure of constant connectivity, notifications, and social media comparisons.
3. **Mobile Usage and Sleep Deprivation:** The relationship between mobile phone usage and sleep deprivation was clearer, with more than 5 hours of mobile usage per day significantly contributing to sleep disturbances. The Decision Tree Classifier revealed that long phone usage, particularly late at night, was a key predictor of students feeling sleep-deprived.

Implications and Recommendations

The results emphasize the need for comprehensive digital wellness initiatives within educational institutions. Universities should adopt policies that promote balanced and mindful mobile phone use, such as designated mobile-free study hours, screen time awareness campaigns, and digital detox challenges. Additionally, orientation and counseling programs can help students develop healthier digital habits and improve time management skills.

Institutions should also integrate digital well-being modules into the curriculum to raise awareness about the psychological and academic impacts of excessive mobile use. Strengthening mental health support systems—including stress management workshops, peer counseling, and sleep hygiene programs—can further assist students in coping with digital fatigue and anxiety.

Finally, regular monitoring and evaluation of students' digital behavior can help educators identify at-risk individuals early and provide targeted interventions to ensure a healthy balance between technology use, academic performance, and mental well-being.

Future digital wellness programs can leverage predictive ML dashboards to monitor students' phone usage and stress indicators, enabling personalized mental health interventions within academic ERP systems.

Limitations and Future Research

Despite the valuable insights obtained, several limitations of the present study must be acknowledged:

1. **Self-Reported Data:** The study relied on self-reported measures for key variables such as GPA, mobile phone usage, and sleep duration. Self-reporting can introduce response bias, as participants may overestimate or underestimate their actual behaviors or academic performance. Future studies could enhance accuracy by incorporating objective data sources, such as institutional academic records or digital usage logs.

2. **Cross-Sectional Research Design:** The study employed a cross-sectional design, capturing data at a single point in time. While this approach allows for identifying relationships between variables, it does not permit conclusions about causality. In other words, it cannot determine whether high mobile usage causes stress and low academic performance, or whether these outcomes influence mobile usage patterns. Future

research could adopt longitudinal or experimental designs, using real-time data collection tools like mobile tracking applications and wearable sleep monitors to establish causal links.

3. **Limited Generalizability:** The findings are based on a specific group of students from a single educational context, which may limit the generalizability of the results. Variations in academic culture, lifestyle, or technological exposure across different institutions or regions could influence outcomes. Therefore, future studies should include larger and more diverse samples, encompassing students from various academic disciplines, institutions, and cultural backgrounds to enhance the external validity of the findings.

4. **Data Imbalance:** The dataset had uneven distribution across stress categories. Future research can use techniques such as SMOTE or ensemble models to balance class representation.

Exploring LSTM or other deep learning architectures could provide temporal insights into behavioral trends across semesters. Future studies could also explore the effectiveness of interventions such as mindfulness and digital detox programs in mitigating the negative impacts of mobile phone use on students' well-being and academic success.

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