

Smartsleepcare: An Assistive Web Application For Identifying Sleep Patterns In Achieving Healthy Lifestyle

Rudolf Jeffrein G. Parlan ¹, Jhomel A. Micabani ², Jomari A. Vargas ³, Criselle J. Centeno ⁴, Raymund M. Dioses ⁵ & Diony S. Abando ⁶

¹Information Technology Department, Pamantasasng ng Lungsod ng Maynila, Manila, Philippines.
Email: rudolfparlan28@gmail.com

²Information Technology Department, Pamantasasng ng Lungsod ng Maynila, Manila, Philippines.
Email: micabanijhomel@gmail.com

³Information Technology Department, Pamantasasng ng Lungsod ng Maynila, Manila, Philippines.
Email: jomarivargas13@gmail.com

⁴Information Technology Department, Pamantasasng ng Lungsod ng Maynila, Manila, Philippines. Email: cjcenteno@plm.edu.ph

⁵Information Technology Department, Pamantasasng ng Lungsod ng Maynila, Manila, Philippines. Email: rmdioses@plm.edu.ph

⁶Information Technology Department, Pamantasasng ng Lungsod ng Maynila, Manila, Philippines.
Email: dswabando@plm.edu.ph

Abstract: SmartSleepCare is a web application designed to identify sleep patterns and promote healthier lifestyles in response to rising sleep-related health issues. Developed in line with ISO 25010 standards, it excels in Functionality, Suitability, Usability, Maintainability, and Portability, with high user satisfaction scores of 4.75 and 4.47. Security, scoring 3.96, highlights a need for improved data protection. The app uses a Random Forest Classifier to analyze sleep data and predict health risks, specifically targeting students at Pamantasan ng Lungsod ng Maynila, many of whom face sleep problems like insomnia and fatigue. It helps users track sleep habits, receive tailored recommendations, and address disruptive factors such as screen time and irregular schedules. Findings underscore the significant impact of poor sleep on productivity and health, making SmartSleepCare a valuable tool for enhancing sleep hygiene. Future updates will focus on bolstering security, expanding machine learning capabilities, and improving portability to better meet user needs.

Keywords: Component, formatting, style, styling, insert.

1. INTRODUCTION

A. Background

Sleep is essential for overall health, supporting physical, mental, and emotional well-being. However, modern lifestyle factors like electronic devices and social media increasingly disrupt sleep patterns and quality. Technological advancements and daily life demands make maintaining consistent, healthy sleep routines challenging, leading to a rise in sleep disorders across all age groups, from children to the elderly.

The study "Sleep Patterns in Achieving Healthy Lifestyle" examines the relationship between sleep patterns and overall well-being, emphasizing the importance of sleep in promoting a healthy lifestyle. It explores factors affecting sleep quality, such as daily routines, screen time, physical activity, and stress, with a particular focus on IT students at Pamantasan ng Lungsod ng Maynila.

During the COVID-19 pandemic, studies by Alomari et al. (2021) and Cordero (2021) highlight significant disruptions in students' sleep habits. Increased internet use, social media engagement, and prolonged screen

time—especially with platforms like TikTok and YouTube—negatively impacted sleep quality. Contributing factors include stress, lack of physical activity, disrupted routines, and social isolation. Breus (2022) further notes that blue light from phone screens delays melatonin production, interfering with the body's natural sleep cycle.

The research aims to identify these factors and provide actionable insights to improve sleep hygiene. Its findings hold potential applications in healthcare, education, and public health, supporting interventions to promote healthy sleep practices and enhance productivity, emotional regulation, and overall well-being. The study seeks to address the rising prevalence of unhealthy sleep patterns among students, underscoring their impact on academic performance and health.

With the assistance of this website, researchers can effectively track students' sleep patterns and assess their sleep quality. By highlighting the connection between sleep and overall health, the research aims to promote better sleep hygiene practices, ultimately leading to enhanced health and an improved quality of life.

B. Objectives

To address the challenges and to help individuals manage and monitor their sleeping habits, promoting a healthier lifestyle:

- **Sleep-pattern tracker** - This project focuses on developing a web application to analyze sleep data, identify patterns, and provide insights, helping users improve their sleep quality through data collection, analysis, visualization, and personalized recommendations.
- **Random Forest model to predict health issues from sleep patterns** - create a Random Forest model that predicts health issues from irregular sleep patterns, analyzing factors like duration, quality, and consistency to identify risks and recommend interventions.
- **Monitoring sleep habit** - The system will track how social media, online games, and work affect sleep using CRUD. This will help people understand how these things impact their sleep and make better choices to improve their sleep.

C. Scope

This website will primarily focus on developing an assistive website for the health sleep habits of the BSIT students of Pamantasan ng Lungsod ng Maynila, which will be a user-friendly online platform and health tracker beneficial. This website will include a login feature through which users can gain access by entering their username and password. Login page, to enable users to gain access to the website. Dashboard, this will allow users to overview what the website offers such as Measuring Health Sleep Prediction, Monitoring Habit Management, and Sleeping Tracker Pattern. This website will have Privacy and Policy in order to protect users. This clarifies the website's rules and expectations, and it demonstrates a commitment to user privacy and data protection. About Page, this will show the description of the website and other necessary things needed for the website. Contact Page, this is where users can reach out to the developer and lastly is the Frequently Asked Questions (FAQs), page that contains answered questions about the website.

D. Delimitations

The project is personalized and will focus only on the students of Pamantasan ng Lungsod ng Maynila who have the experience of having unhealthy sleep habits or sleep deprivation. As for developing and designing the website the researchers will use PHP, HTML, CSS, JavaScript, Python as programming and markup languages. The said website will essentially generate a recommendation on how to improve healthy sleeping

habits and avoid sleep deprivation. The website will primarily be based on the data that users have submitted in the forms that are provided. For the deployment of this project, this will be intended for the use of everyone since it is a personalized used website but due to time constraints, the researchers were unable to collect a comprehensive range of data sets, which could potentially limit the accuracy and robustness of our predictions feature.

2. METHODOLOGY

A. System Methodology

This section details the development methodology and design of the SmartSleepCare assistive website application for identifying sleep patterns in achieving healthy lifestyle.

1. Development Methodology

In this development phase, researchers will gather data on students' bedtime habits, device usage, and causes of sleep deprivation while ensuring privacy and data protection. Flowcharts and diagrams will be created to outline the website's user experience, helping identify potential issues. The development team will use a relevant framework and distribute tasks for the website's design and functionality, with a focus on testing the Health Sleep Habit Prediction algorithm. The website will be evaluated for performance, security, and efficiency, addressing any bugs. It will be accessible only to BSIT students at Pamantasan ng Lungsod ng Maynila, with guidance provided for its use. This phase will assess progress and identify areas for future improvement.

This study utilized Visual Studio Code and Xampp as the main software tools. Visual Studio Code supports a variety of markup and programming languages, offering customization through themes and plugins, many of which are community-developed and maintained under free software licenses. It serves as a streamlined code editor, assisting with tasks like execution, debugging, and version control. Xampp, on the other hand, includes the Apache HTTP Server, a database, and interpreters for PHP scripts.

2. Theoretical Framework

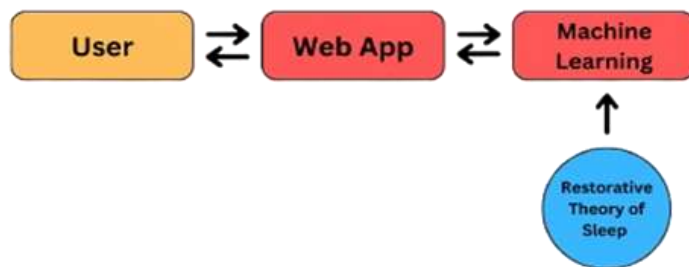


Fig 1. Theoretical Framework of SmartSleepCare

Figure 1 discusses Oswald's restoration theory why sleep is important with theory if sleep where it explains what will happen to human lifestyle if they have enough hours of sleep. Having enough sleep makes the human body feel energized. The study provides theoretical support for the proposition that helping individuals to understand why human need to restore and by knowing how important sleep is, it will boost the mental and physical health it will also help the individual to prevent any disease they might get in lacking sleep or sleep deprivation, particularly in the context of sleep and lifestyle support applications like SmartSleepCare.

3. CONCEPTUAL FRAMEWORK

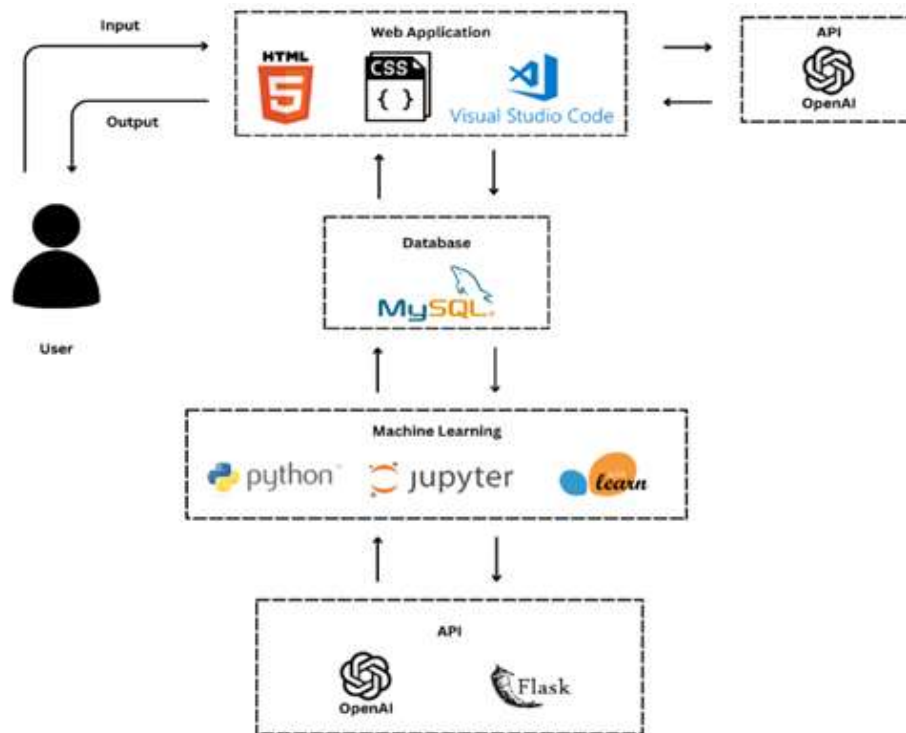


Fig 1. Conceptual Framework of SmartSleepCare

Figure 1 illustrates the conceptual framework of this study, which includes probability prediction and a web application. The web application was developed using Visual Studio Code, HTML5, CSS, Python, and PhpMyAdmin MySQL as central hub for user interaction and data management. The system integrates both frontend and backend components to enhance efficiency and user friendliness. User interaction and configuration are stored in MySQL database. The machine learning algorithm needed a trained dataset to perform a prediction, it must be programmed using Python language including Jupyter Notebook and Scikit-Learn.

Additionally, the backend is powered by Flask, a lightweight Python framework that facilitates smooth communication between the frontend, database, and machine learning layers. Flask also manages API endpoints, including external integrations like OpenAI, to ensure a cohesive data flow across all components. Jupyter Notebook facilitates data exploration and support machine learning such RandomForestClassifier for the probability prediction of illnesses that causes the human to deprived sleep it also employs Scikit-Learn model for analysis and classification.

B. Machine Learning / Algorithm Development

This section delves into the machine learning model's training and development for the automation of SmartSleepCare : An Assistive website application for identifying sleep patterns in achieving healthy lifestyle.

- **Dataset Collection**

Before implementing the Random Forest classification model, the dataset must be carefully prepared. For SmartSleepCare, the dataset collection involves employing a random sampling technique to ensure a fair and representative selection of data points. This approach guarantees that every individual in the population has an equal chance of being included, reducing bias and enhancing the model's generalizability. The process is conducted with proper authorizations, approval from the university administration, and open communication with former faculty candidates. To ensure data security and privacy, strict protocols such as encryption and secure storage are followed.

The dataset focuses on students' sleeping habits and the frequency of staying awake late at night. Random sampling begins with clearly defining the population, determining an adequate sample size, assigning unique identifiers to participants, and using methods like random number generators for selection. The selected data is combined with freely available online datasets to increase diversity. Additionally, synthetic data generation techniques are applied to create new data points based on observed patterns, further enriching the dataset.

The prepared data is used to train the Random Forest classifier, a robust and versatile machine learning model. This model builds multiple decision trees during training, using random subsets of the data and features to ensure diversity and reduce overfitting. The predictions from all trees are aggregated through majority voting, resulting in a model that is accurate, reliable, and resistant to noise. The Random Forest classifier's ability to handle high-dimensional data and provide insights into feature importance makes it ideal for analyzing sleep patterns and classifying behavior. This comprehensive approach ensures the SmartSleepCare system can effectively detect and generalize patterns, even when the initial dataset is limited or incomplete.

- **Random forest Classification**

The Random Forest classifier is a versatile and powerful tool in machine learning, commonly used for classification tasks, where it assigns labels to data points based on learned patterns. It is particularly useful in fields like fraud detection, sentiment analysis, and customer behavior prediction. A key feature of Random Forest is its ability to perform feature importance analysis, revealing which variables contribute most significantly to predictions. This makes it ideal for applications such as identifying factors that affect consumer preferences or detecting unusual patterns in large datasets.

One of the major advantages of Random Forest is its robustness against overfitting. By training multiple decision trees on random subsets of the data and features, it mitigates the overfitting problem that can arise with individual decision trees. The combination of tree predictions through majority voting improves the accuracy and reliability of the model. Additionally, Random Forest is well-suited for handling complex datasets with both categorical and numerical data, and it can manage missing values and imbalanced classes with ease. Its adaptability to noisy or incomplete data ensures consistent performance, making it an excellent choice for tackling real-world machine learning challenges.

C. System Evaluation

- **Sampling Techniques**

A simple random sampling method was employed to select 112 respondents from a larger pool. Each respondent was randomly chosen to ensure that every individual in the population had an equal chance of being selected. These participants were then provided with an evaluation form to assess their overall satisfaction and experience with the website. By using simple random sampling, the survey results are

expected to offer an unbiased representation of the population's views, allowing for reliable conclusions regarding the effectiveness and user satisfaction of the system.

- **Basis for Evaluation**

The standard quality model is base according to the ISO/IEC 25010 standards, which outline a framework for assessing software quality. These standards focus on key quality characteristics, including Functionality, Suitability, Usability, Security, Maintainability, and Portability. The testing process ensured that the app met its intended requirements, functioned correctly, and was suitable for its purpose. Usability was also a key focus, evaluating how intuitive and user-friendly the app was. Additionally, security measures were scrutinized to protect data and prevent vulnerabilities, while maintainability and portability tests ensured the app's adaptability to future updates and various platforms. These questions are classified based on the criteria used from the ISO 25010 standard to ensure a comprehensive evaluation of the app's overall performance and quality.

- **Evaluation Metrics**

The survey included questions aligned with the ISO 25010:2011 standard, aimed at evaluating the effectiveness of the Smartsleepcare web application. A total of 112 participants responded, and the questions were categorized according to the standard's quality characteristics to ensure a comprehensive assessment of the application's overall performance.

Table 1. Effectiveness Scale

Numerical Scale	Descriptive Rating
5	Excellent
4	Very Good
3	Satisfactory
2	Fair
1	Poor

Table 1 outlines the numerical ratings that correspond to the qualitative evaluations detailed in Table 1. The numerical ratings are categorized as follows: Excellent (5), Very Good (4), Good (3), Fair (2), and Poor (1). This categorization was established through a frequency distribution analysis.

- **Confusion Matrix**

Table 2. Confusion Matrix

	Predicted Positive	Predicted Negative
Actual Positive	True Positive (TP)	False Negative (FN)
Actual Negative	False Positive (FP)	True Negative (TN)

Table 2. shows the confusion matrix helps in diagnosing the performance of a classification model by showing not only the overall accuracy but also how well the model is distinguishing between different classes. In cases of class imbalance (where one class is much more frequent than the other), metrics like precision, recall, and F1-score derived from the confusion matrix become particularly important because they provide a more detailed view of model performance than just accuracy.

in a SmartSleepCare system, if the task is to classify whether a student stays HEALTHY (positive) or UNHEALTHY (negative), the confusion matrix will help assess how well the model is distinguishing between students who stay up late and those who do not, giving insights into potential misclassifications and how to improve the model's performance.

3. RESULTS

A. Confusion Matrix of Random Forest Classification

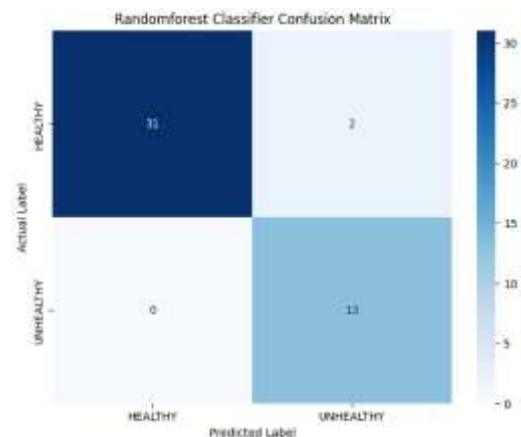


Fig 2. Confusion Matrix of Random Forest Classification

Fig 2. displays a confusion matrix for the Random Forest Classifier model, which is used to evaluate the classification performance. In the matrix, the rows represent the actual classes (True Labels) and the columns represent the predicted classes (Predicted Labels). The top-left cell shows that 31 HEALTHY instances were correctly predicted as HEALTHY, which is a true positive (TP). The top-right cell shows that 2 HEALTHY instances were incorrectly predicted as UNHEALTHY, which is a false positive (FP). The bottom-left cell indicates that no UNHEALTHY instances were incorrectly predicted as HEALTHY (false negative, FN). The bottom-right cell shows that 13 UNHEALTHY instances were correctly predicted as UNHEALTHY, which is another true positive (TP). Overall, the confusion matrix indicates that the model performs well in classifying both classes. There are no false negatives for the UNHEALTHY class, meaning all actual UNHEALTHY instances were correctly identified. However, there are 2 false positives for the HEALTHY class, where two instances that were actually HEALTHY were misclassified as UNHEALTHY. This aligns with the classification report, where the UNHEALTHY class achieved perfect recall (100%) and the HEALTHY class had a high recall of 94%, with perfect precision (100%). This shows that the model generally performs well with minimal errors.

B. Classification Report of Random Forest Classification

Classification Report for Randomforest Classifier:				
	precision	recall	f1-score	support
HEALTHY	1.00	0.94	0.97	33
UNHEALTHY	0.87	1.00	0.93	13
accuracy			0.96	46
macro avg	0.93	0.97	0.95	46
weighted avg	0.96	0.96	0.96	46

Fig 3. Classification report of Random Forest Classification

Fig 3. presents a Classification Report generated by the Random Forest Classifier model, which evaluates the model's performance in a classification task. The report includes several important metrics for each class (HEALTHY and UNHEALTHY), as well as overall performance measures. For the HEALTHY class, the model shows perfect precision (1.00), meaning all predictions for this class were correct. However, its recall is 0.94, indicating that 94% of the true "HEALTHY" instances were correctly identified by the model. The F1-score for the HEALTHY class is 0.97, which is a balanced measure of both precision and recall. On the other hand, for the UNHEALTHY class, precision is somewhat lower at 0.87, meaning 87% of the predicted "UNHEALTHY" labels were correct. The recall for this class is perfect (1.00), indicating that the model successfully identified all actual "UNHEALTHY" instances. The F1-score for UNHEALTHY is 0.93, which is also strong but slightly lower than the HEALTHY class. In terms of overall performance, the model achieved an accuracy of 96%, meaning it correctly predicted the class for 96% of the instances. The macro average considers the average of precision, recall, and F1-score for each class, resulting in a precision of 0.93, recall of 0.97, and F1-score of 0.95. The weighted average, which takes into account the class imbalance, gives a precision of 0.96, recall of 0.96, and F1-score of 0.96. The report reveals that while the model is highly accurate overall, it performs better in predicting the HEALTHY class, with perfect precision but slightly lower recall. In contrast, the model excels in recall for the UNHEALTHY class, identifying all such instances but with a slight trade-off in precision. To improve the model, one could adjust the hyperparameters, balance the class distribution, or introduce more data, especially for the minority class, to help enhance performance across both classes.

C. Overall Evaluation of the Objectives of SmartSleepCare

Table III. Overall Evaluation for Smartsleepcare

Criteria	Mean	Interpretation
Functionality Suitability	4.75	Excellent
Usability	4.47	Very Satisfied
Security	3.96	Satisfied
Maintainability	4.17	Very Satisfied
Portability	4.23	Very Satisfied

Table 3 shows the overall mean evaluation results. It demonstrates that the application performs well in terms of functionality, usability, maintainability, and portability. However, there is still room for improvement in terms of security. Specifically, the application received an excellent rating of 4.75 for Functional Suitability, indicating that it effectively meets its intended functions. Additionally, it received very satisfied ratings of 4.47 for Usability, 4.17 for Maintainability, and 4.23 for Portability, suggesting that it is easy to use, maintain, and adapt to different environments. While the application received a satisfied rating of 3.96 for Security, there is potential for further enhancement in this area to ensure a higher level of protection. Overall, the application is well-suited for its intended use, easy to use and maintain, and adaptable to different environments, but there is a need to address potential security vulnerabilities.

4. DISCUSSION

A. SUMMARY OF FINDINGS

The researchers gathered evaluations from students and personal users using Google Forms, employing a 5-point Likert scale. The overall mean of the ISO Evaluation is 4.31, indicating a strong need for a tool like SmartSleepCare. The results demonstrate that having a web application that raises awareness of sleep health, provides valuable insights on sleep patterns, and predicts potential health risks using current data is considered highly useful and convenient by the evaluators. Developing such an application can effectively improve sleep habits and potentially prevent health issues related to poor sleep, making SmartSleepCare a valuable resource for personal well-being.

A key aspect of the system is its use of supervised machine learning, specifically a Random Forest Classifier model, to analyze sleep patterns. This model classifies sleep as healthy or unhealthy, and when unhealthy, it predicts the likelihood of related illnesses. By integrating machine learning, the system offers personalized health insights based on user data, enhancing its overall utility. Results from ISO 25010 testing confirmed this with high scores in functional suitability (mean score of 4.75) and usability (mean score of 4.47), showcasing the system's effectiveness and user satisfaction. SmartSleepCare is a highly functional, user-friendly, and adaptable tool for sleep pattern monitoring, utilizing supervised machine learning to provide tailored health predictions. The researchers' hybrid approach to gathering user feedback was instrumental in refining the application's design and functionality. With the use of the SmartSleepCare web application, students and personal users will be empowered to change their lifestyle and improve their sleeping habits, reducing the likelihood of developing sleep-related illnesses. While the application excels in functionality, usability, and maintainability, enhancing its security features would further solidify its reliability and boost user confidence.

B. CONCLUSION

The evaluation of the SmartSleepCare web application highlights its exceptional performance in functional suitability and usability, achieving mean scores of 4.75 and 4.47, respectively. These results indicate a strong agreement among users that the application effectively fulfills its primary functions, such as monitoring sleep patterns and providing health predictions. Furthermore, its user-friendly design ensures ease of navigation, with the majority of respondents expressing high satisfaction. This feedback confirms the application's ability to meet user needs while enhancing their understanding of sleep health.

In terms of security, the application was rated with a mean score of 3.96, categorizing it as satisfactory. While users generally feel that their data is securely managed, the findings suggest room for improvement in data protection measures. Strengthening these features is critical for building greater user confidence, particularly because the application deals with sensitive health-related information.

Additionally, the SmartSleepCare application has been recognized for its positive impact on sleep health awareness. By leveraging supervised machine learning, the platform provides valuable insights into sleep habits and identifies potential health risks. Users widely acknowledge its role in improving sleep patterns and reducing the likelihood of sleep-related health issues, underscoring its importance in promoting well-being in today's health-conscious environment.

Overall, with an ISO evaluation mean of 4.31, the SmartSleepCare application demonstrates strong performance in functionality, usability, maintainability, and portability. While it is highly effective in providing personalized insights into sleep health, addressing the identified security concerns will further enhance its reliability and user trust. By refining these areas, the application can continue to empower individuals to improve their sleep habits, ultimately contributing to better overall health and quality of life.

C. RECOMMENDATIONS

Testing and evaluating SmartSleepCare has led to several recommendations for enhancing its functionality, usability, and overall performance. First, the security features should be improved by introducing password change options, account recovery features, two-factor authentication, and encrypted user credentials to strengthen data protection and user trust. Additionally, completing the machine learning prediction module is crucial for enhancing functionality, allowing the application to provide advanced insights such as sleep pattern analysis and personalized health recommendations.

Furthermore, the system's portability should be increased by optimizing it for various devices and screen sizes to ensure seamless cross-platform compatibility and improve the user experience. Comprehensive documentation, including clear developer guidelines and API instructions, should also be developed to facilitate future updates and smooth transitions between development teams. Lastly, system performance must be further optimized to maintain responsiveness and speed, especially as complex features like machine learning models are integrated. These improvements will ensure the application continues to meet user needs effectively while enhancing its reliability and impact.

ACKNOWLEDGMENT:

A heartfelt thank you to everyone who contributed to the success of this thesis defense. We are deeply grateful to our thesis adviser, Criselle J. Centeno, for her invaluable guidance and support. Thanks also to the thesis committee members, Prof. Diony S. Abando and Prof. Raymund M. Dioses, for their insightful feedback. Special thanks to our former professors, Prof. Mark Anthony S. Mercado, Prof. Ariel Antwaun Rolando C. Sison, and Prof. Joseph Darwin C. Co, for their essential assistance. We also appreciate Ms. Diana Jane Saya for her help in formatting the thesis. Our classmates' support, encouragement, and friendship have been a key part of this journey. We are truly grateful to our families, friends, and loved ones for their constant belief and presence. Finally, we thank Almighty God for His blessings and guidance throughout this endeavor.

REFERENCES

1. Al-Wandi, A. S., & Shorbagi, S. (2020b). Sleep patterns and its relation to lifestyle habits: a study of secondary high school students in Sharjah, United Arab Emirates. *AIMS Public Health*, 7(3), 713–722. <https://doi.org/10.3934/publichealth.2020055>
2. Gold, B., & Windscheid, J. (2020). Observing 360-degree classroom videos – Effects of video type on presence, emotions, workload, classroom observations, and ratings of teaching quality. *Computers & Education*, 156, 103960. <https://doi.org/10.1016/j.compedu.2020.103960>
3. Social Media Victims Law Center PLLC. (2023b, August 3). Social media and sleep deprivation | Social Media Victims Law Center. Social Media Victims Law Center. <https://socialmediavictims.org/effects-of-social-media/sleep-deprivation/>
4. Tambayan, D. (2023, March 19). How Heavy Workload Affects Student Learning Outcomes • DepEd Tambayan. DepEd Tambayan. <https://depedtambayan.net/heavy-workload-affects-student-learning-outcomes/>
5. Wang, F., & Biró, É. (2021). Determinants of sleep quality in college students: A literature review. *Explore-the Journal of Science and Healing*, 17(2), 170–177. <https://doi.org/10.1016/j.explore.2020.11.003>
6. Xi, N., Juan, C., Gama, F., Riar, M., & Hamari, J. (2022). The challenges of entering the metaverse: An experiment on the effect of extended reality on workload. *Information Systems Frontiers*. <https://doi.org/10.1007/s10796-022-10244-x>

7. Yang, C., Chen, A., & Chen, Y. (2021). College students' stress and health in the COVID-19 pandemic: The role of academic workload, separation from school, and fears of contagion. PLOS ONE, 16(2), e0246676. <https://doi.org/10.1371/journal.pone.0246676>