Sleep.io: Engineering a Comprehensive Sleep Tracking and Analysis Platform

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By

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Academic Integrity Statement

By submitting this dissertation, I agree that:

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- It does not exceed the specified page limit.
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Abstract

In this dissertation, I present Sleep.io, a comprehensive sleep tracking and analysis platform, emphasizing user-friendliness and functional design for all demographics. The project presents sophisticated PHP-based data processing techniques combined with Chart.js's user-friendly data visualisation features. It documents my system architecture journey showing extensive development thorough planning, rigorous testing, and overall project management. In addition to improving my technical proficiency in PHP, JavaScript and other coding languages, this experience has helped me gain a deeper grasp of user-focused design and the significance of dependable database structuring for tailored user experiences.

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Chapter One: Problem Specification/Introduction

1. The problem at Hand

The global issue of sleep deprivation and its repercussions on overall health and productivity stands as an important issue. It has an impact on individuals from all areas of life, regardless of age, gender, or income. Lack of sleep leads to a range of health complications, including as obesity, heart disease, and mental disorders, which therefore puts the UNSDGs for good health and well-being in jeopardy (SDG 3). It additionally impacts productivity and cognitive function, which has an impact on economic growth and education therefore relating two UNSDGs to each other, being quality education (SDG 4) and economic growth (SDG 8). The scope of this problem is vast; millions of people experience sleep-related issues that negatively impact their general quality of life.

1.2 My Proposed Solution

My goal is to lessen and help with the sleep deprivation issue that the modern citizen faces by giving individuals a practical and simply available tool to track, monitor, and improve their sleep habits. I plan for this platform to be an accessible and practical solution that will improve the lives of an immense number of individuals whilst helping to collectively accomplish these important UNSDGs.

I believe that implementing this concept will greatly boost productivity and health whilst addressing the widespread issue of sleep deprivation.

Through this people may prioritise acquiring adequate sleep, leading to improved lifestyles, and increasing the achievement of significant UNSDGs.

2. Description of the Problem Domain

2.1 Relevance to UNSDG:

My aim in tackling the sleep deprivation issue is directly in line with the UNSDG 3 of: Good Health and wellbeing. My objective is that by monitoring, tracking, and reporting feedback on sleep the target user will see significant health improvements and therefore positively impact the development goals in ‘Good Health and Wellbeing’.

2.2 Specific Problem and Its Impact:

Lack of sleep (Sleep deprivation) is an incredibly prevalent issue not only in the UK/Ireland but on a global scale also. According to a survey conducted by the (Dr Doug Wright, 2017), as many as 16 million UK adults are suffering from sleepless nights with almost half (48%) of UK adults admitting that they don’t get the correct amount of sleep[1]. For individuals such as these the effects on health can range from benign to severe, with low quality sleep being linked to issues such as increased risks of chronic health conditions such as cardiovascular disease, diabetes, and obesity. Significant impacts on cognitive function such as low alertness and concentration. As well as dire impacts to one’s mental health. Additionally, on a broader scale on society the issue of lack of sleep is dire. The economic affect is

[1] https://www.aviva.com/newsroom/news-releases/2017/10/Sleepless-cities-revealed-as-one-in-three-adults-suffer-from-insomnia/

significant as indicated with a study by ‘Rand Europe’ which estimates that the UK loses £40 billion

annually due to lost productivity from sleep-related issues and by the (Hafner, 2016), which estimates the economic cost in Ireland at approximately €2.86 billion annually[2].

2.3 Who is Impacted:

All sorts of people are impacted by sleep issues. As previously stated, 48% of UK adults suffer from less than sufficient sleep, leading to increases in stress, anxiety, and depression, paired with an array of cognitive impacts. Of these individuals’ notable groups would include:

HealthCare Workers: Poor sleep is a problem for more than 80% of Irish people[3], which adds to the strain on the healthcare system and therefore leading to raises in healthcare demand. (irishexaminer.com, 2018)

Employees: A lack of sleep decreases productivity (According to a Harvard study of 7,480 adults found a 23.2 percent population-wide prevalence of insomnia and estimated 11.3 days of lost productivity among these poor sleepers. (Kemmis, 2019)[4]), and in the UK, tiredness is a factor in 20% of traffic accidents[5]. (rospa.com, n.d.) To keep a productive workforce, employers must address sleep disorders because absenteeism and poor performance on the job increase expenditures.

Families and Caregivers: Families and carers who help people with sleep disorders confront constant difficulties. They must modify habits and provide care and due to the mental and physical toll this can be severe. It's important for both people with sleep disorders and those who provide care to seek treatment.

2.4 Potential for Positive Change:

A sleeping monitoring website has great potential to improve both society and individuals:

Individuals: By utilising the website to track and improve their sleep, people can enjoy healthier lives, less medical complications, and greater mental health. The platform I intend to design offers personalised recommendations along with insights which would assist users in treating their sleep issues and enhancing their quality of sleep.

Society: With a greater number of individuals using sleep tracking and adopting better sleep habits, society can save money on healthcare costs whilst generating more productive workers. A population that is healthier, more attentive, and more productive has significant positive effects on society.

2.5 Importance of Addressing the Problem:

As sleep is fundamental to general health and wellbeing, addressing sleep health is of the highest priority. For people to grow, adequate, sound sleep is not a luxury, but a basic requirement and long-term sleep deprivation and sleep disturbances have been linked to an array of physical and mental health problems, impaired cognitive performance, and an increased chance of developing chronic illnesses.

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[2] https://www.rand.org/randeurope/research/projects/the-value-of-the-sleep-economy.html
[3] https://www.irishexaminer.com/news/arid-30836477.html
[4] https://zapier.com/blog/sleep-and-productivity/
[5] https://www.rospa.com/media/documents/road-safety/driver-fatigue-factsheet.pdf

My proposed platform provides users the ability to take charge of their sleep health. Through the provision of tools for self-evaluation, education, and tailored suggestions users can experience enhanced well-being, a decrease in healthcare complications. Additionally, along

with this an increase in productivity in both their personal and professional lives through better sleep quality and early detection of sleep disorders.

3. Current Systems in Use

There are several current systems in use that aim to tackle the sleep problem through both technical and non-technical solutions. Some of these approaches include:

1. Sleep Diaries: The most traditional sense of sleep tracking would be with sleep diaries to monitor, track and analyse sleep patterns. Many individuals and even health care professionals still rely on this method to diagnose themselves/patients. Whilst these diaries can track patterns such as bedtime/wake time, sleep duration and perceived sleep quality, a traditional sleep diary can highly inaccurate due to self-reporting, memory lapses and user biases.
2. Wearable devices: More advanced sleep monitoring methods such as features found in smart watches and smart rings have been implemented more and more to accurately track the sleep patterns of users. Using sensors to monitor movement, heart rate and sometimes having the ability to monitor blood oxygen levels these devices can track a user's sleep quality without the problems found in manual tracking such as memory lapses/biases. However, these devices can still be subjected to limited accuracy as well as technical issues like battery drainage.
3. Polysomnography (PSG): perhaps in the most advance methods, and traditionally in a clinical setting PSG would be used. This method typically is used to diagnose sleep disorders through user of sensors on the patient's body to monitor their brain activity, eye movements, heart rate, muscle movement and more. Although it is highly accurate and effective it is expensive, time-consuming, and quite impractical for personal home use.
4. Non-technical Approaches: The most basic system for sleep aid would be non-technical approaches such as monitoring caffeine intake, relaxation techniques, or specific nightly/bedtime routines. However these would more be solutions and remedies that would be prescribed by these stated technical methods.

Through the evaluation of these methods its clear to see that each has its merits as well as limitations. Whether it be some are accessible and cost-effective whilst some stride in terms of accuracy and depth, I see an opportunity to expand and combine a diverse range of features comprehensively to innovate this sector of sleep health. Through features and like user-centric design, accurate and clear data tracking I plan to educate, visualise, advise, and personalize information in an aim to improve user sleep health.

4. Detailed Description of the General Target Audience

As sleep health is a broad and prevalent issue with all demographics the sleep tracking website application, I intend to design will generally be open and not limited to any one type of user. However, there are specific users who I intend to target this application at as the target audience:

a. Individuals that Seek to Improve Sleep:

The primary users of my sleep tracking website would likely be users who are looking to monitor and improve their sleep patterns for specific personal reasons. This group could be diverse and span across a range of ages, demographics, and lifestyles all with the shared goal sleep improvement.

Characteristics/Needs:

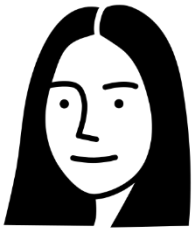
Characteristics these individuals would share would assumingly be difficulty falling asleep, poor quality sleep and general sleep disturbance. These could be sought out for many diverse reasons such as reducing stress, enhancing concentration, bettering overall health, or improving productivity.

i. Healthcare Workers:

Additionally, my platform can also be highly beneficial to healthcare faculty, such as doctors, nurse and other healthcare professionals that are particularized in the domain of sleep health. This platform could be effectively utilized to collect data on areas such as sleep patterns, trends and anomalies which could all be used to aid in the diagnosis and treatment of sleep disorders, as well as helping in the making of informed decisions.

5. Personas

Persona 1: Jane – Stressed Nurse



Background: Sarah is a 30-year-old nurse in a stressful career. She has trouble managing her family life, job, and other personal obligations and is often missing important sleep.

Needs: Sarah needs to track her sleep so that she can optimise her sleep habits, reduce stress, and improve her overall health. She is looking for a user-friendly applications that feels handy.

Persona 2: Owen – Personal Trainer

Background: Owen, a 25-year-old personal trainer who's looking to optimize his sleep to further aid in their muscle recovery and performance.

Needs: Owen is looking for a system that can track his sleep so that he can receive feedback on his sleep quality, he can then use this feedback to help in his fitness goals. He values data accuracy and informative feedback.

Persona 3: Mike – Sleep-Deprived Student

Background: Mike is a 22-year-old university student studying software engineering. He is frequently missing assignments and late to classes due to irregular sleep patterns. He struggles to fall asleep due to too much time at night on his phone/laptop and further due to bad lifestyle choices such as diet and alcohol consumption.

Needs: Mike is looking or a system that can help his overall wellbeing and mental focus through informative lifestyle suggestions. He values clarity in information and extensive suggestions.

6.1 **Data Privacy and Security:**

Data privacy is essential to any systems that is looking to collect users personal information/data (Such as sleep patterns, duration, or any personal details). To combat against any personal data leaks encryption and data protection measures are to be put in place as well the precise handling of data when considering where someone's data will be presented within the application.

6.2 **Accessibility:**

The second social and ethical considerations to account for would be accessibility. Its import for websites such as this which are open to many different user types, that they are user-

friendly and accessible. For this to be ensured, guidelines such as the WCAG(Web Content Accessibility Guidelines) (https://www.w3.org/, n.d.).

6.3 **Mental Health:**

The mental health and wellbeing of the individual user cannot be understated. It is crucial to consider the potential impacts that could cause any unnecessary distress. Feedback that overly critical or alarming to the user could result in undue stress or anxiety. However, on the other hand, any feedback that would be excessively positive could also promote a mindset of complacency which could then further lead to a continuation of sleep issues. The Sleep tracking website must find a balance when presenting this information.

7. Proposed Solution:

My solution is ‘Sleep.io’ A Website designed to track, monitor, analyse and report on a user sleep patterns, duration and quality to find solutions for improvement. The website will be user-friendly and comprehensive to best communicate with the user. Key Features would include:

- **Personalized profiles:** Users will have the ability to register and login to their individual profiles, providing information such as age, gender, and other personal information. This will help personalize insights and recommendations.
- **Data analysis:** Through data analysis algorithms the data will be collected and analysed, examining sleep stages, disturbances, and other patterns. By comparing this gathered data to recommended benchmarks, the website will report back on insights and recommendations.
- **Visualisation:** This Sleep data will then be presented in a user-friendly and understandable format with the user of charts, graphs, summaries, and clear figures. Visualisation will give the user and immediate overview on their sleep patterns to allow them to adjust and track their progress.
- **Insights and recommendations:** Furthermore, along with the visualisation of information, insights and recommendations will be presented to the user based on the analysed sleep data such as bedtime routines, dietary adjustments, and recommended readings.

Chapter Two: The Proposed Solution and Software Lifecycle

2.1 Introduction

As previously stated, my solution to these challenges and problems is 'Sleep.io', 'The website to track, monitor and analyse your sleep patterns'. This web-based project will be crafted with the intention of being 1) User-friendly: An aim of the platform will be to be effective in its ease of use, layout, navigation, and overall user experience. As laid out in chapter one this purpose is to make sure the platform is accessible to all demographics as sleep is a universal experience that all potential users will want to manage and track. Having a positive user experience should therefore be of primary concern. 2)Function: The second primary focus of development is functionality of the product. This means innovative coding development, formula creation, and rigours testing all to guarantee a fully functioning and reliable product that the end user can use repeatedly, effectively and with complete trust. These requirements mean extensive planning is not only desirable but necessary.

2.2 Software Development Lifecycle: The Waterfall Model

During development of 'Sleep.io' I made the conscious decision to adhere to the 'Waterfall model' (Atlassian.com, n.d.)[6]. This choice was made purely on the fact that the waterfall model offers a straightforward, linear approach to software development, facilitating continual building and improvements as project continued. This model supports a structured progression through distinct phases, ensuring clarity and a well-documented path from conception to conclusion. This approach was made possible through use of GitHub (github.com, n.d.), the ability to continual commit incremental progress over a stretch of time proved incredibly beneficial in helping document and save progress through use of the waterfall method.

2.3 General Requirements and Elicitation

The development of 'Sleep.io' was built upon a firm understanding of user requirements. Recognizing that the essence of a successful application lies on aligning a user's needs with the product, meant that a comprehensive approach to find what users genuinely sought for in a sleep tracking platform was required. Further research into this problem leads me to illuminating two primary user needs in this regard (Grigsby-Toussaint, 2017)[7]:

1) Data entry and data retrieval: User emphasized the need for a straightforward way to input data into a sleep system to be stored, as well as equally emphasizing the importance of data retrieval. The option to review your stored information/sleep history is of primary concern.
2) Sleep Analysis: The user needs for sleep analysis are core to the use of sleep tracking. Whilst the logging and retrieval of sleep history is important, users primary concern when reviewing their sleep data is to analyse and review their sleep quality through complex formulas, algorithms, and functions.

Sleep.io's proposed solution incorporates several key features, including *personalized profiles*, advanced *data analysis*, *visual data presentation*, and *insights and recommendations* tailored to individual users. These features are underpinned by a

[6] https://www.atlassian.com/agile/project-management/waterfall-methodology
[7] https://pubmed.ncbi.nlm.nih.gov/28316907/

technological stack, including HTML (html.com, n.d.),CSS (W3.org, n.d.)(with (TailWindCSS, n.d.)for design efficiency), JavaScript (developer.mozilla.org, n.d.) (Chart.js (chartjs.org, n.d.)for data visualization), PHP (php.net, n.d.) for server-side scripting, and MySQL (mysql.com, n.d.) for data storage. This technology stack was selected for its reliability, ease of use, and strong community support, aligning with the project's goals of accessibility and user engagement.

2.4 User Requirements and How This Influences Development

During the Sleep.io development process, optimising the user experience within every aspect has been the highest priority. The foundation of this project is reliability, actionable insights, and ease of use—all essential user criteria.

Usability is essential because Sleep.io wants to serve a wide range of users. This means that everyone can use the platform and navigate it successfully, regardless of their level of technological expertise. Second, users need more than just raw data; they need insightful analysis that enables them to better understand and manage their sleep patterns. This is why Sleep.io's functionality is built to deliver process data, in the forms of scores and recommendations. Finally, dependability serves as the basis of every aspect of the system, from strong back-end processing to an organised database, guaranteeing that users will always have a satisfying experience using Sleep.io. Each of these pillars—Storing data, functionality, and ease of use—is essential to the user-centred design concept that guided Sleep.io's development. Let’s look at how each of this user requirements will be addressed by the system design.

2.4.1 Ease-of-Use

1) Navigation

Navigation plays a pivotal role in the user experience of any application. In Sleep.io, ensuring that the navigation is effortless and intuitive is crucial because it allows users from all demographics to interact with the platform without difficulty. Seamless navigation ensures that users can focus on their primary goal on the site—tracking and understanding their sleep patterns—without being hindered by complex site mechanics.

The layout of Sleep.io is designed to guide the user naturally from the moment they log in to when they begin tracking their sleep. Upon logging in, the user is taken to the home page, which is designed with clear, intuitive scrolling and a layout that prominently displays the essential features. A key aspect of this design is the strategic placement of the button that leads to the tracker page. This design choice not only streamlines the user journey but also minimizes the time and effort required to start tracking sleep, enhancing the overall user experience. A wireframe of this layout can be seen below to visually demonstrate the user flow and design thought process.

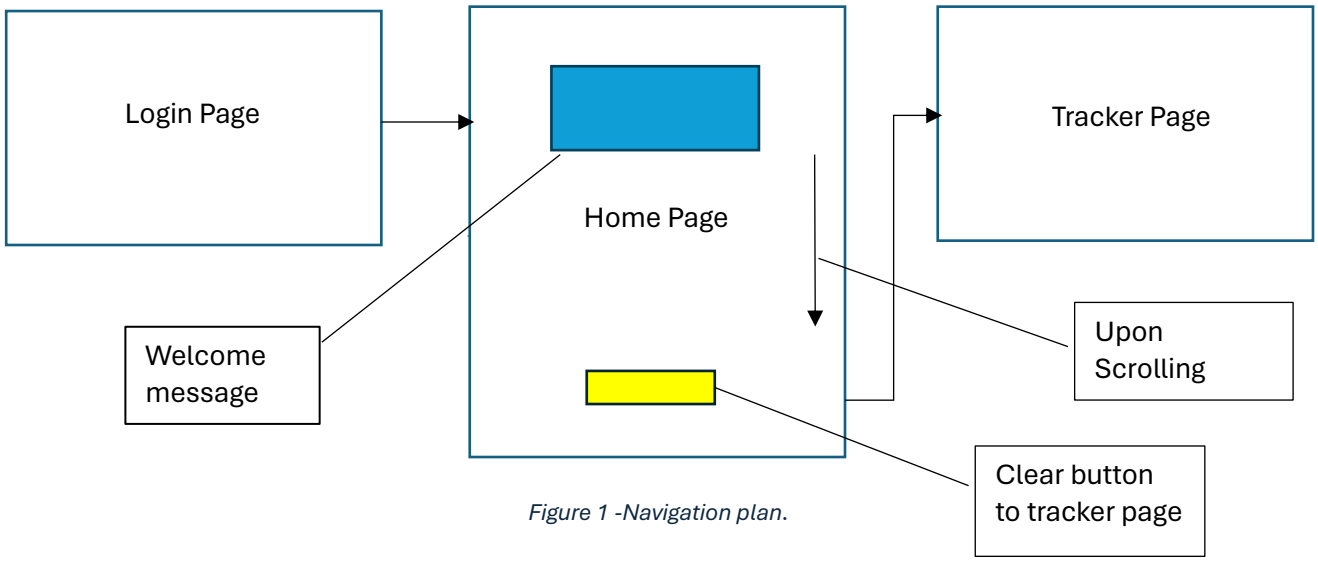


Figure 1 -Navigation plan.

Sleep.io ensures that the navigation system not only meets but also enhances the user experience by making the platform accessible and easy to use for everyone. This foundational design philosophy supports the overarching goal of making sleep tracking as straightforward and beneficial as possible.

2) Consistency and Clarity

It's important to keep the user experience of a health app like Sleep.io clear and consistent. Users of different ages and technical abilities may efficiently explore and utilise the site without misunderstanding due to a clear and consistent interface. This is especially significant for applications pertaining to health because the precision and usability of entering vital health data like sleep patterns is essential.

Using Frameworks for Clean Design

To achieve this high level of consistency and clarity, Sleep.io employs Tailwind CSS, a utility-first CSS framework known for enabling fast and efficient design. Tailwind's design system allows us to maintain a uniform style guide across all components and pages, fostering a cohesive user experience. This consistency helps build user trust and comfort, as they find the environment familiar and easy to interact with each time they log in.

Advantages of Minimalist Design

Sleep.io follows the minimalist design style of Tailwind. By minimising visual clutter, this strategy improves the platform's usability in addition to its aesthetic appeal. Data entry is simple and error-free due to this minimalism, which guarantees that users may concentrate on their main duties without interruptions. An interface that is both harmonious and easy to use is produced by the minimalist design, which also enhances the clarity that Tailwind's regular use offers.

2.4.2 Functionality

1) PHP functions for sleep analysis

The objective is to develop a fully functioning platform that effectively analyses user-inputted data through PHP functions, this is a core user requirement . We want to turn this sleep data into insights that can be used, not just stored. By doing this, we improve the user's understanding and make it possible to employ this knowledge practically to benefit sleep patterns and general health. To live up to user expectations, this system offers detailed feedback, as well as individualised sleep health measures based on daily inputs.

Sleep.io will operate on a foundation of data analysis that will ensure a uniquely tailored experience for each individual user. The system will:

i) Take inputted data such as ‘wake times’, ‘sleep times’, ‘quality of sleep’ and ‘comments’. These variables will be stored and later used within various functions in order formulate and generate numerous unique data display points.
ii) Use these numerous data display points and variables, to preform calculations for methods such as: *number of total sleeps, sleep streaks, average sleep time*. Further advanced calculations will include *Sleep score, Sleep consistency and estimated sleep cycle.*

Each of these different pages will share some calculations and also have exclusive calculations to their own, this will be specific to each page depending on the pages purpose. For a deeper understanding of these functions and calculations, how they work and how they operate please refer to Appendix A - A1.

2) How I Plan to Create and Use These Functions

PHP is essential to the development of Sleep.io because of its strong server-side processing and database interface handling capabilities. This is crucial since a large portion of our application depends on getting and modifying data from databases. PHP scripts do all the heavy lifting, from analysing sleep data to carrying out intricate computations that serve as the foundation for our user insights.

We use Chart.js to present this data once it has been processed. The choice of Chart.js is based on how well it can transform unstructured data into visually appealing and understandable representations. It is a great option for making slick graphs that improve user experience without being overbearing due to its basic style and mild learning curve. The visually appealing and interactive features of Chart.js charts contribute to the meaningful understanding of the data in addition to making it visible.

Utilising PHP and Chart.js, a comprehensive strategy will be used to efficiently meet Sleep.io's user needs. The development method will handle each requirement as follows:

Requirement 1 - User Registration and Login: PHP will be used to manage user data while creating a safe and user-friendly user registration and login page. To retain user states across sites and provide a safe and customised experience, sessions will be used. Data security will be ensured by input validation.

Requirement 2 – Sleep/Wake Time Data Entry: Users will be able to simply input and submit their sleep and wake times using PHP/HTML forms in the tracker page. The user-friendliness of these forms will be prioritised in their design, ensuring that even users with limited technical skills may easily enter data.

Requirement 3 – Sleep Quality Rating and Comments: PHP will be used to record quality input and evaluations for sleep quality in addition to the numerical data. The sleep input form will have a grading system and a comment section so that users can log their personal sleep experiences.

Requirement 4 – Sleep Score Generation: To generate a sleep score, a complex PHP algorithm will evaluate the duration and quality of the sleep. With the use of this score, users will be able measure their sleep in a way that can be tracked over time to evaluate improvements and changes.

Requirement 5 – Visualization of Sleep Stages: The sleep data will be displayed as a hypnogram chart using Chart.js. The many stages of sleep that occur during the night will be shown on this chart, giving consumers an easy-to-understand and instructive graphical depiction of their sleep cycle.

Requirement 6 – Historical Data Review: The database will be queried using PHP to collect and display historical sleep data. By looking back at previous entries and tracking trends over time, users will be able to have a better knowledge of their sleeping habits.

2.4.3 Storing of Data – Database Overview

Leaving behind the dynamic functionality that comes with Chart.js and PHP, it is essential to ground these operations in a strong system architecture and dependable database structure. The well-thought-out data architecture of Sleep.io, which is intended to provide resilience and responsiveness to user activities, is the cornerstone of its dependability.

System Architecture

Scalability and maintainability are key considerations in the design of Sleep.io's architecture. This calls for a different definition of the display layer, logic layer, and data access layer as well as a clear separation of responsibilities. This kind of structure makes it easier to create and maintain the system, and it also makes it more adaptable to changing user requirements.

Database Design

A cornerstone of our platform's reliability is its database design. To efficiently store and manage user data and sleep information, we employ a relational database model, meticulously structured to support our application's needs.

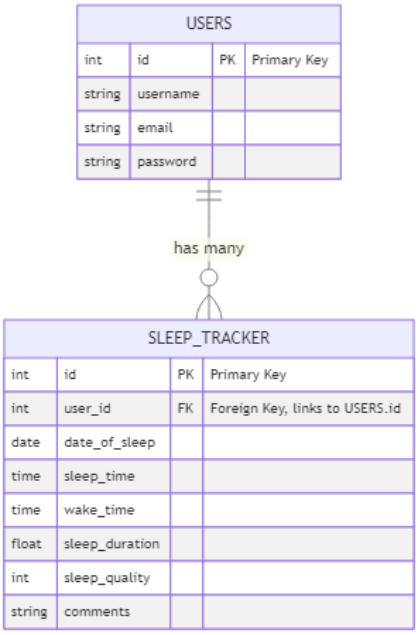


Figure 2 - Database ER Diagram

User Table

The user table is created with the focus of storing and maintaining user specific information. This Information is necessary for creating personalized experience and recommendations with Sleep.io. The fields within this table are purposed and laid accordingly:

id: A unique identifier for each user. This will serve as the primary key within the table.

username: The user's chosen name when registering. This is for identification within the platform.

email: For potential login verification/communication.

password: For security.

The user’s table is fundamental for the registration and authentication processes, enabling personalized interactions with the application.

Sleep Tracker Table

The **sleep_tracker** table Is the primary table used behind Sleep.io’s data analytics and functionality. The storing of user information is crucial in the development of personalized

data set and results. Having the appropriate data fields and stores is important for these functions. These fields are:

id: A unique identifier for each user. This will serve as the primary key within the table.

user_id: A foreign key. this creates a relationship to the users table and links sleep data to the user.

date_of_sleep: The date when the sleep occurred.

sleep_time and wake_time: Timestamps for when the user fell asleep and woke up.

sleep_duration: The total time spent sleeping. This is calculated from sleep_time and wake_time.

sleep_quality: A listing of categories to judge the sleep quality off. These range from 'Very Bad' to 'Excellent'.

comments: Additional notes the user enters to comment on another sleep events/disturbance/further information they'd like to add.

Relational Diagram

The relational diagram depicts the connection between the users and sleep_tracker tables. The one-to-many relationship indicates that a single user can have multiple entries in the sleep_tracker table, each representing a different sleep session. This relationship is crucial for aggregating and analysing sleep data to provide personalized insights.

Relational Keys: The user_id field in the sleep_tracker table is the foreign key that links to the id field in the user's table.

Integrity Constraints: These ensure that sleep data cannot exist without an associated user, maintaining data integrity across the application.

The data design for Sleep.io, as delineated through these tables and the relational diagram, provides a clear, structured format for storing and analysing user sleep data. This structure supports Sleep.io's primary functionalities, from user account management to the granular tracking of sleep patterns, integral for the generation of actionable sleep improvement insights. The database schema effectively facilitates Sleep.io's objective of helping users achieve better sleep quality through personalized experiences and data-driven feedback.

Chapter 3: User Interface Design, System Design, and Implementation

3.1 Introduction to User Interface Design

When I started designing Sleep.io, my goal was to create a platform where the calmness of a night and the smoothness of modern technology would naturally come together to enhance one another. My aim was to create a user interface (UI) that can offer both a calming and natural experience for the user to align with the principles of sleep health. With Sleep.io, I sought to create a platform that all users regardless of ability or demographic could navigate with ease, making the effort of tracking sleep fall away.

To create this atmosphere, I made sure the UI consisted of nightly colours – deep blues, purples to represent the afternoon sky along with starry visuals, and warm oranges and yellows to evoke a morning vibrance emulating a wakefulness. I'd like to discuss here my websites design, layout, and general thoughts on the UI design decisions I made and why I made them. Page layout, colour choices, and other HCI principals where meticulously created consciously with ideas and thoughts behind each.

3.2 Website Layout and Design Considerations

One of my primary focuses with Sleep.io was to have a natural layout that flowed seamlessly for the user. As this is an application for all demographics my objective with sleep.io is to have the system be accessible to all and that is why site layout is of primary importance. Careful consideration was given to Sleep.io's navigational structure to ensure that users had a seamless user journey from their first encounter to regular usage.

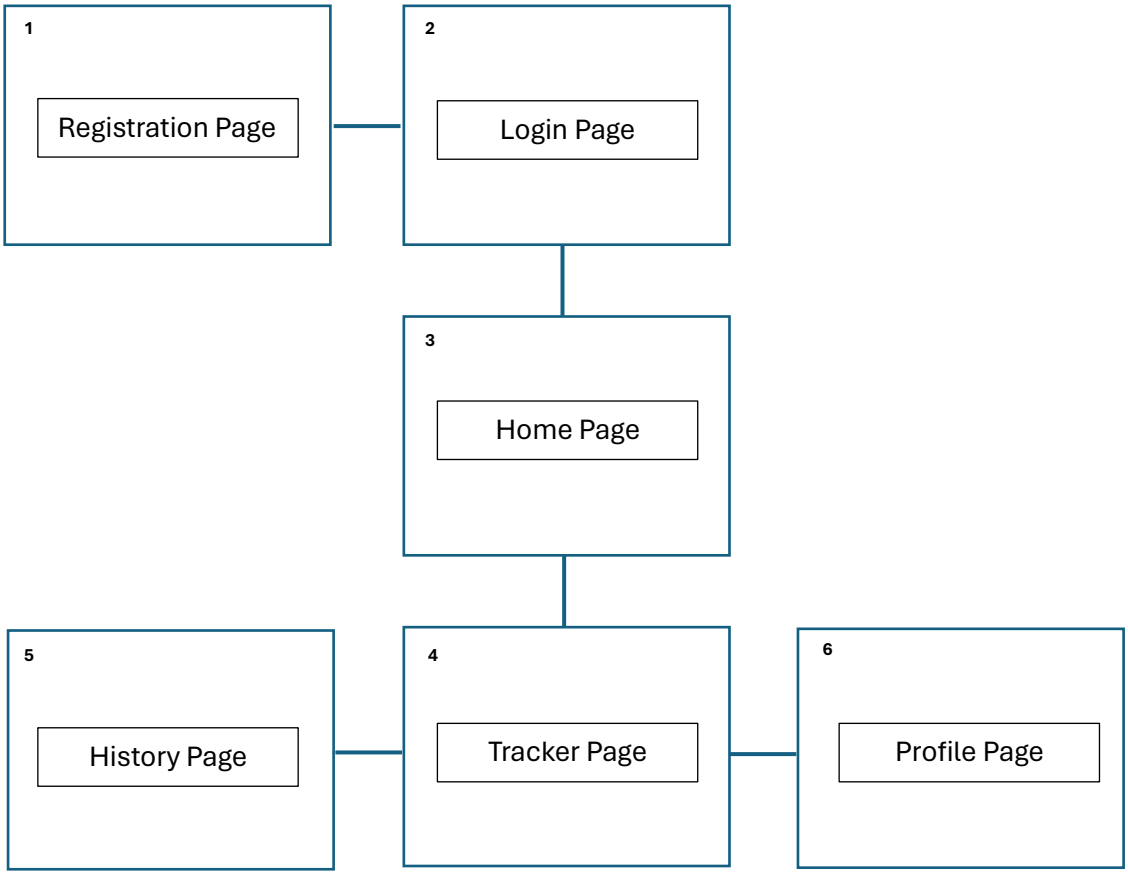


Figure 2 - Site Map

3.2.1 A high-level overlook

Beginning with the registration Page (1), this was envisioned to be the users first touchpoint with ‘Sleep.io’. I kept this page minimalistic and simple, I wanted Sleep.io to not feel over complicated and this starts with the first age of Sleep.io. Upon completion of the registration page, the user is then guided to the Login Page (2). The login page then serves as the secure gateway into the personalized site of Sleep.io.

Proceeding on from the login page the user is met with the Home Page (3), which functions as the operational centre of Sleep.io. The design of this site was to not just to provide the users with a comprehensive array of features and navigation, but to set an atmosphere of professionalism and ease. From here the users can navigate to multiple pages, however, the natural first option upon scrolling is to use travel to the Tracker Page (4). The tracker page is the centrepiece of ‘Sleep.io’. This is where the user will log their data and be provided with a range of insights and analytics. I designed this section to be as straightforward as possible, encouraging user engagement.

The History Page (5) and the Profile Page (6) are two equally critical components of Sleep.io. These two pages function similarly in that they both are personalized pages to the user that will show the user a plethora of personal data related to the user sleep journey. Where they differ however is primarily information display. The history page’s purpose is to display the user with a list of all their sleep entries and to chart and display these sleep entries over time, whilst the profile page is more tailored to show processed data, such as sleep scores and consistency scores.

3.2.2 First contact with Sleep.io

Registration Page (1) & Login page (2):

The user’s initial engagement with the site I feel was very important. The registration and login process server as a gateway into Sleep.io and set an overall tone for the user’s experience. I wanted this tone to largely be set whenever the user entered the home page, and therefore kept the initial registration/login pages simple and straightforward.

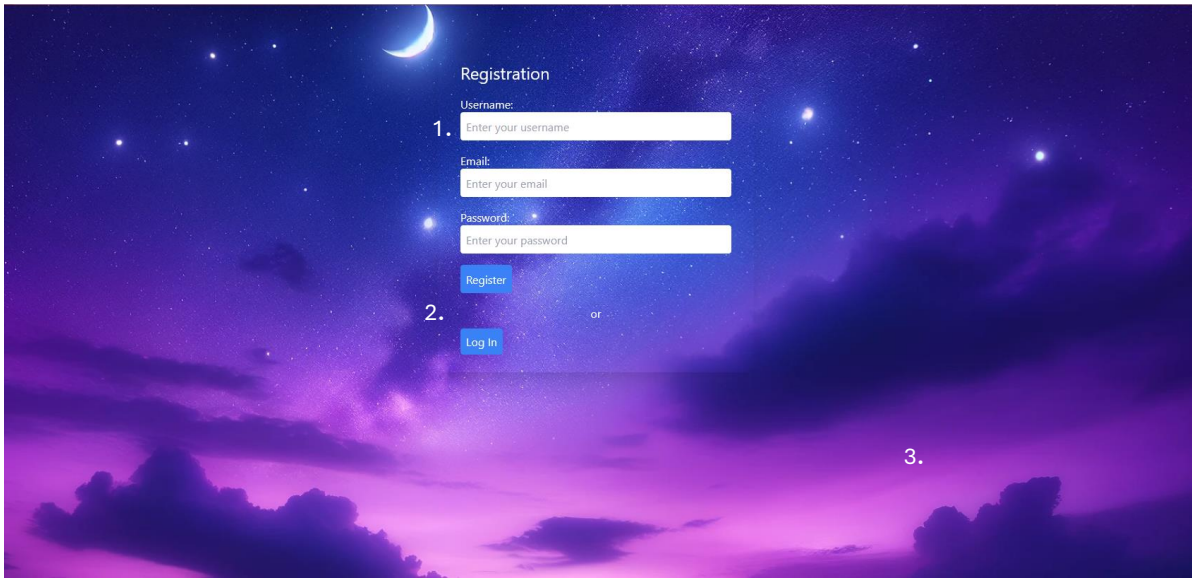


Figure 3- Registration Page

1). The input fields being of primary focus of the page are presented in order or *Username, Email,* and *Password.* This format adheres to the basic format across all website design standards with the password typically being last.

2). Highlighted in blue as to be easy to see are the *register* and *login* buttons. These serve as the entry ways into 'Sleep.io'. I arranged these with conscious consideration; the 'Register' button is the displayed to be clicked when your details are inputted to officially register your own account onto 'Sleep.io', from here the Registration page will take you to the login page so you can log the details you previously entered. When clicking on the 'Login' button you will be also taken to the login page to enter details (assuming you have already registered previously)

3). Considerable focus was given to the website design, the choice of a calm night sky was implemented to set the atmosphere of 'Sleep.io', additionally the choice of the transparent registration box was in effort to have 'Sleep.io' feel less like a ridged program and more of a natural site.

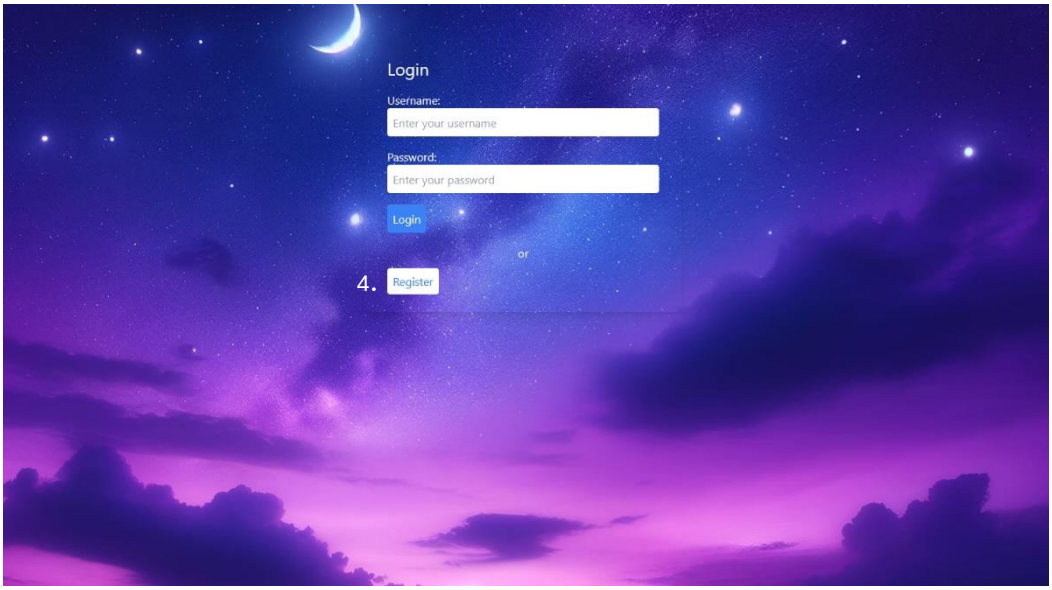


Figure 4 - Login Page

4). To keep a consitent design I wanted the transition from a Regstration to login to be seemless. For this I kept the exact same layout, design and images to create this effect, the only difference being the subtle change of colour to the 'Register' button. This was a consious choice as I felt it was appropiate in the deisgn choice to guide the user to the registration page if they have not done so already.

3.2.3 The Core Sleep.io

The Home Page (3)

Beyond the login pages user are introduced to the core of 'Sleep.io' – the Home Page (3), a comprehensive suit that forms the essence of the user experience. I created the home page as a gateway to the platforms primary functions of: tracking, reviewing ones history and personal profile. The design of the home page was developed with intuitiveness in mind, allowing the user to navigate the site seemiessiy from area to area. I streamline the layout to the home page to natrually give users a path to tracker page next. The home page I developed blends a natural motion of useablitiy with simple navigation.Upon entering sleep.io, rather than to barrage the user with information, users are greeted with a gradual materialization of the welcome message. I chose this approach deliberately to mirror the gentle ease of sleep and tranquillity. The fade-in animation is subtle but purposeful, created to reflect the core ethos of 'Sleep.io': Peace and calm to improve one sleep. I wanted to make sure that the home page laid the foundation for the user to engage and entrust the site, anticipating the utilities of Sleep.io.

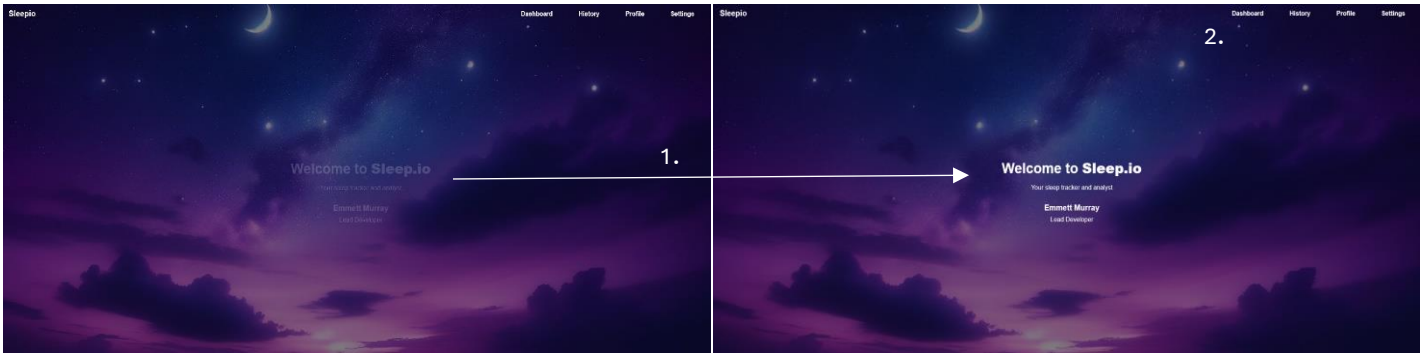


Figure 5 - Home Page, Fade In

1). The fade in animation employs CSS3 transition that provide a smooth, gradual fade of content. JavaScript timing functions are tuned to align with user preferences, assuring that fade in times is to abrupt nor too sluggish.

2). Adhering to UX best practices the navigation bar appears as responsive, subtle, and practical. The navigation bar is a staple across all pages on the site meaning that users can navigate from one page to any other page with ease. The navigation bar always appears as transparent meaning that the navigation bar can always adapt to which ever page it is appearing on, therefore avoiding removing any appeal from the selected page.

These features serve as an example of Sleep.io's dedication to becoming far more than a tool for sleep analysis; they are also an area where users can interact with their sleep patterns in a serene, organised environment, aided with graphics and personal-touch interactions.

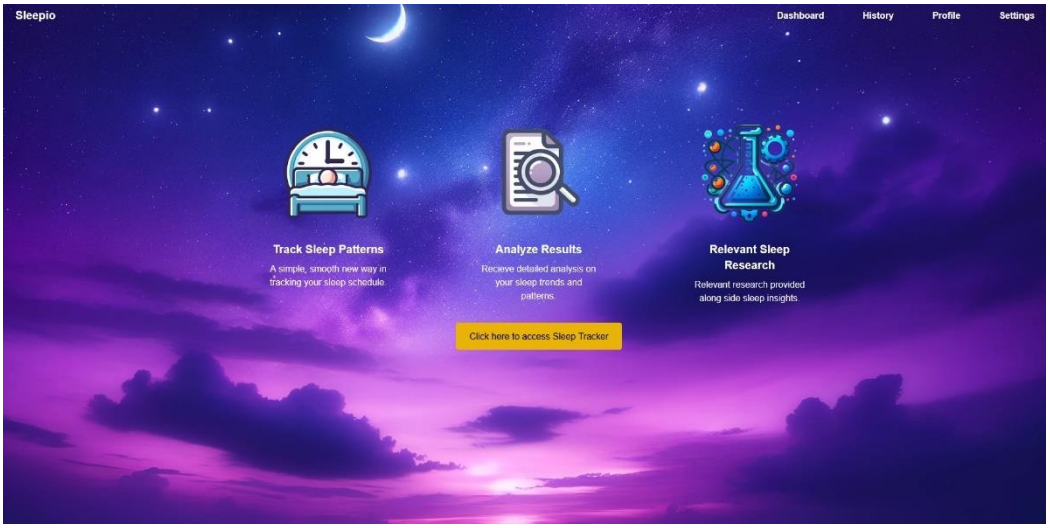


Figure 6 - Section 2 of Home Page

As users scroll, they will next be met by a dynamic display of icons for tracking sleep, analysing results, and accessing sleep research fade into view, punctuated by a prominent 'Click here to access sleep tracker' button. Again, using seamless effects for added professionalism, this section serves as an interactive gateway for seamlessly ushering the user from the home pages to the practical tools that will be found in the Tracker Page (4).

Tracker Page (4) – Section 1

The tracker page, which is where users will spend the majority of their time on Sleep.io, here serves as the platform's centrepiece and its most vibrant and dynamic feature. This page offers swift, clear insights that precede the longer assessments found in the History and Profile sections. It is intended to provide not only a summary of daily sleep but also a more in-depth examination of sleep patterns relevant to the users previously given sleep. Here, the idea of sleep is translated into concrete facts so that the user can engage with and evaluate their sleeping habits. With a user-centric design, the tracker page ensures that each contact feels intuitive and natural motivating the user toward improved sleep health. I wanted to make sure that the area of logging sleep information was felt like a central hub to the user as to make there experience more enjoyable and engaging.

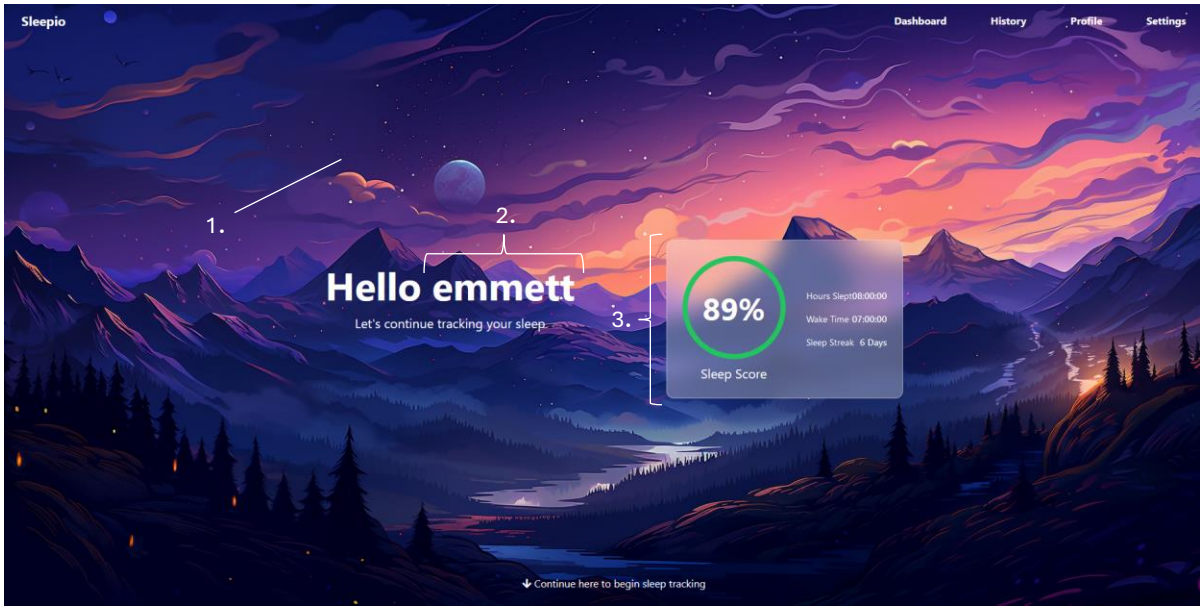


Figure 7 - Tracker Page - Section 1 - Sleep Statistics

1). The backdrop of the Sleep.io tracker page is designed to subtly foster a peaceful and restful mindset in addition to captivating the user with its calm evening scenery. The selection of a sunset mountain view, with its calming colour scheme of warm oranges and deep purples, reflects the tranquilly that one should associate with sound sleep. Assuming users are likely to use this tool in the evening before bed or in the morning after there sleep, I am hoping this could reflect the peace of either evening or morning.

2). Upon logging in a user can expect a personalised greeting of "Hello [username]", this serves as the first marker of personalization for the user and serves as warm introduction to the Sleep.io foundation. Increasing the user's sense of involvement and ownership of a platform is a core design choice of strengthening the bond between and user and a platform, this is crucial in any health-related platform.

3). A primary component of the tracker page is the 'Sleep Statistics Widget' – a visually engaging and personalized dashboard that presents the user with an immediate snapshot of their recent sleep achievements. This widget is presented to have maximum visibility, serving a quick feedback loop, rewarding the users with an earned sense of accomplishment through a dynamic display of the sleep score, hours slept, wake times, and sleep streak.

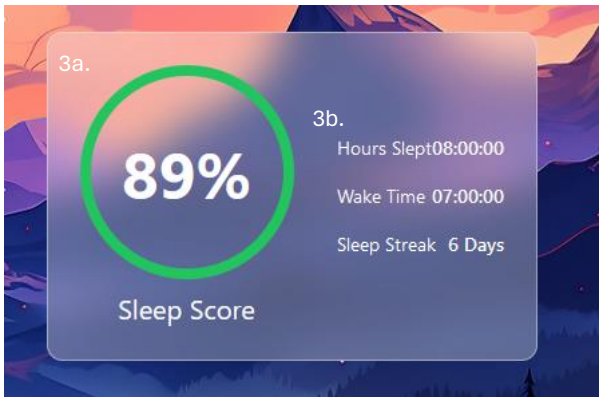


Figure 8 - Sleep Statistic Widget

3a). *Sleep Score:* The sleep score visualization serves as a focal point for the user. The score is purposefully prominent to demand immediate attention, additionally its placement against the quiet background enhances instead of detracting from the peaceful experience which Sleep.io aims to deliver.

3b). *Sleep Details:* As this section preludes the trackers input form, I wanted to make sure that the user was provided with relevant information they would want to know before again tracking their sleep. Hours slept and wake times appeared to be the clearest choice as these could set a light goal for the user to replicate these statistics for the sleep they will be about to undertake. Additionally, having a

sleep streak gamifies the sleep tracking subtly, this is in attempt to motivate the user towards habitual sleep patterns.

The Tracker Page – Section 2

The second part of the tracker page is where Sleep.io's user involvement takes centre stage. This is a key interface where data entry and analytical insights come together. Users are greeted with a simplified form that is easy to use and effectively developed, making it possible to enter sleep variables quickly and with little difficulty. The suggested sleep time graph in the following picture reinforces the tracker's role as a daily companion in the user's journey towards better sleep health by offering instant, personalised feedback based on recent sleep patterns. This part best captures the essence of Sleep.io: the seamless merging of user input simplicity with sophisticated data-driven advice to make sure users feel understood and guided in a way that feels effortless.

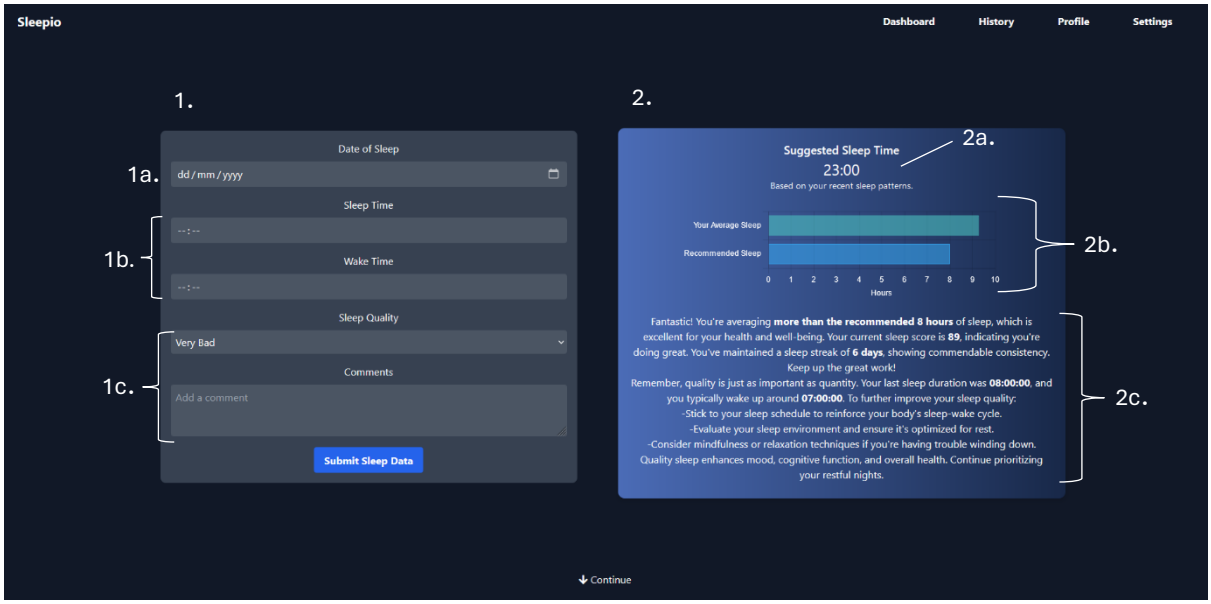


Figure 9 - Sleep Input Form

Feature 1 – Input Form

The input form is designed to be aligned with HCI design principles and general UI/UX development. Having the most important features at the beginning and descending into the secondary features finalised by the submit button once all the information is entered.

1a. – Date of Sleep: Placed at the beginning of the form as this is the most important piece of information, from here all sleeps can be logged and all subsequent information about the given date can be associated and later used. Complemented with a calendar icon for ease of use this not only beckons the users with a sense of familiarity but also simplifies the process of logging sleep.

1b. – Wake Time and Sleep Time Inputs: For the wake/sleep times 'Sleep.io' adopts a streamlined approach, favouring a simple 24-hour clock format. This choice was made to minimise confusion sometimes made with AM/PM formats as emphasis is made to create a platform that is dedicated to accuracy and clarity. To ensure this accuracy manual sleep inputs were designed in order for users to enable exact recordings of sleep and wake times.

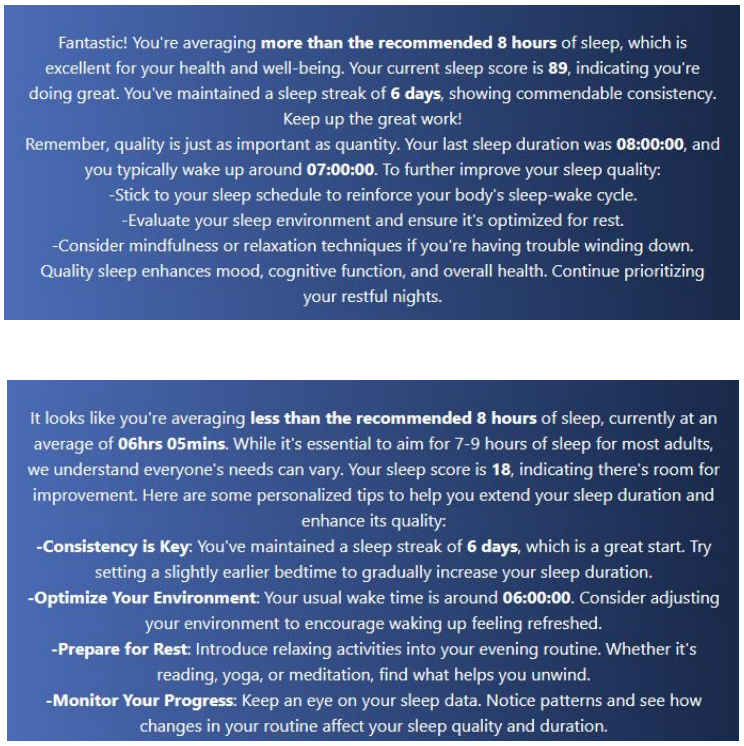
1c. – Sleep Quality and Comments: Users can simple asses their nights sleep quality with the use of the drop-down list, these options range from Very Bad to Excellent depending on the user's opinion of their sleep. This simple method emphasises the value of the user's feedback on their sleep analysis by streamlining there tracking procedure and having a direct impact on their personal sleep score depending on what rating they chose. Following this Is the comments section, this is a follow-up to the quality input and to the form in general as any additional information that the user may want to input can be included here for later review. This is a very important feature as it allows users to be less confined to given inputs.

Feature 2 – Suggested Sleep Time Graph

2a. – Suggested Sleep Time: The 'Suggested Sleep Time' function on Sleep.io is at the forefront of Sleep.io demonstrating the site's dynamic user interface. This feature, which suggests the ideal bedtime by intelligently analysing previous sleep data, is a prime example of reactive design. This component is placed at the helm of this section as a clear reminder of that nights (or the following) nights ideal bedtime, gently nudging the user to a more optimal sleep.

2b. - Sleep Time Graph: the Sleep time graphs purpose is a visual indicator of the user current performance in terms of there sleep average. By juxtaposing the research recommended standard of eight hours, users can have a quick and intuitive way of understanding their current sleep patterns.

2c – Textual Sleep Information: Following on from the visual indicators of the users sleep patterns is then the textual sleep information. Created as a way to see into one's sleep patterns more in depth everything in this section stands as information the user would primarily like to know before proceeding with there next night sleep as to give them the best way to make a healthy informed decision. This information is dynamic in two ways; 1. The information has many change points where certain words and information change dynamically based on the users sleep history (*Highlighted where text is bold)*, and 2. Depending on whether user is getting less or more than 8-hour sleep as recommended.



Change of information depending upon whether user is getting **more** than eight hours sleep.

Note, recommendations are highlighted for users with below recommended hours, as to bring awareness to sleep health tips

Figure 10 - Textual Sleep Information

The Tracker Page – Section 3

Through the 'Predicted Sleep Cycle' feature, users can delve into the details of their sleep architecture in the carefully assembled Section 3 of Sleep.io. The focal point of the segment, this thorough visualisation provides a customised hypnogram that traces the progression of several stages of sleep throughout a night. The user's understanding of their sleep quality is heightened by the percentage breakdown to the left, which provides a statistical summary of the amount of time spent in each sleep phase. An adaptive information panel reacts to the user's interaction and dynamically displays rich information about each phase of sleep to the right. Each of these components come together to create a comprehensive tool for sleep analysis, supported by sophisticated UI/UX design concepts that put the needs of the user, clarity, and education first.

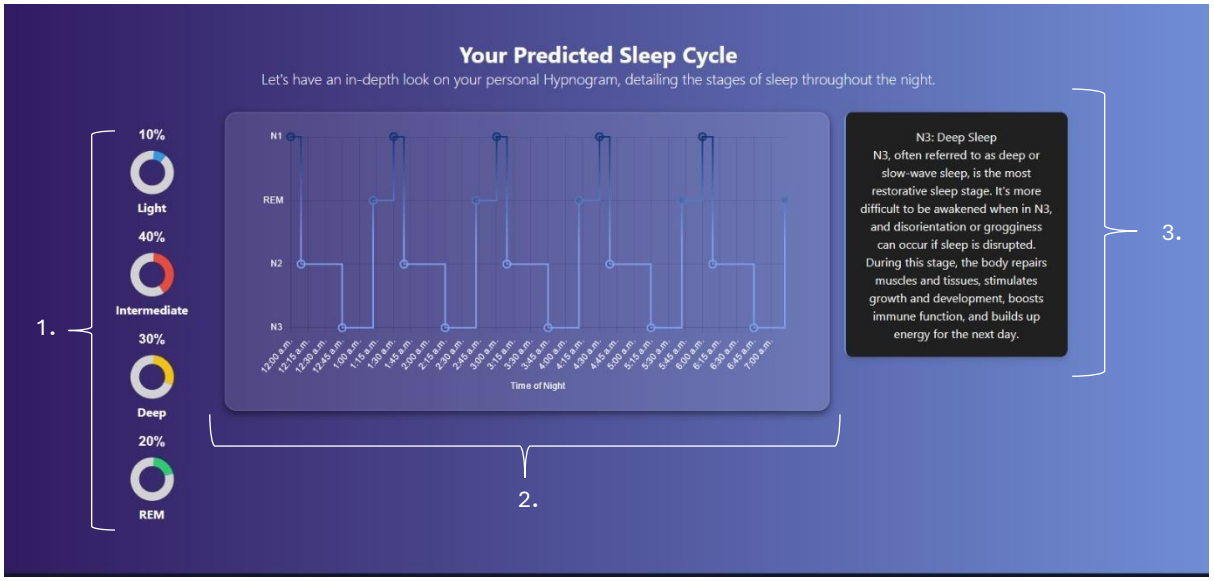


Figure 11 - Hypnogram Graph and Information

1. Sleep Stage Percentages - Sleep.io's UI/UX design is excels in Section 3's examination of sleep percentages as it is easily navigable and visually clear. The circular progress indicators provide users with an instant visual assessment of their sleep distribution for the night, with each one representing a different sleep stage. The accompanying percentages give a numerical reference to these visual clues, and the color-coding system, which was carefully selected for its visual impact and recognizability. Additionally, the design is inclusive; substitutes like color-coded patterns take colour-blind users' demands into account, making the interface legible to a wide range of users.

2. Hypnogram Graph- The Hypnogram Graph, a detailed representation of the user's sleep architecture, is the central component of Section 3. Precisely tracking the progression through the different stages of sleep is made possible by the positioning of each vertical line and connecting dot. Users can easily identify their sleep patterns as to the timeline's minimalistic appearance, blending simplicity and detail. Hover tooltips, for example, are interactive elements that appear when the mouse hovers over them and provides a more detailed explanation of each step, so bridging the gap between information and understanding. The interactive feature of the graph does more for users than just look nice; it lets them interact with their sleep data and turns seemingly uninteresting data into an intriguing instructive story. The graph's design revolves around this natural interaction, which creates an engaging user experience that delves beneath the surface of sleep analysis.

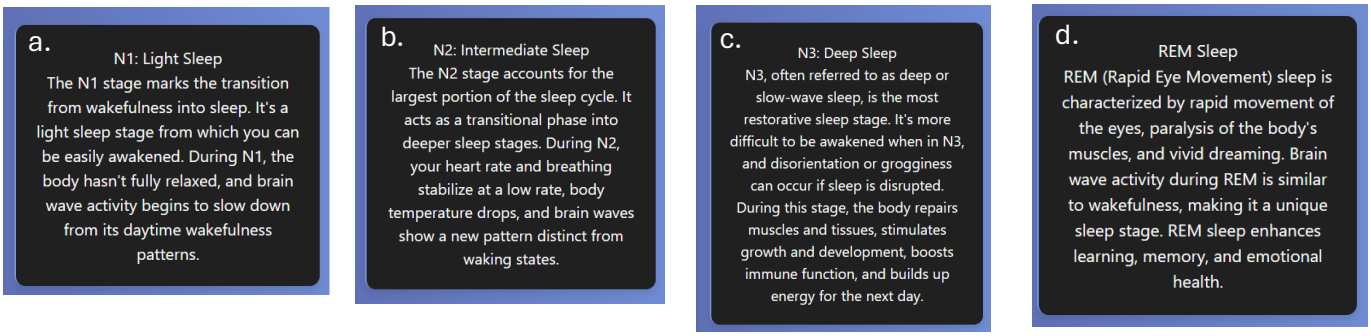


Figure 12 - Sleep Stage Information

3. Information Panel - Sleep.io's Information Panel in Section 3 serves as an interactive educational tool designed to help clarify the intricacies of each stage of sleep. Hovering over the initial (a)light sleep phase, (b)intermediate sleep, (c)deep sleep, or the (d)REM sleep causes the panel to appear. It displays information unique to each stage in clear, legible writing against a soothing background. Brief explanations of the physiological modifications and the significance of each stage in relation to the entire sleep cycle are given in each panel. The content smoothly integrates data with instruction as the user moves from one level to the next, adapting dynamically to reflect the special qualities and importance of each one. This carefully thought-out interaction aims to both enlighten and deeply engage consumers, creating a comprehensive understanding of the users sleep journey.

The History Page (6)

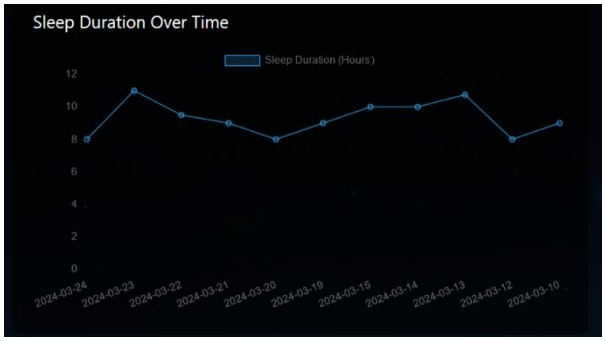
Sleep.io's History page acts as a straightforward ledger, providing users access to an unprocessed, readable record of their sleep information. This area is devoted to displaying raw inputs; unlike the profile and tracker pages, which provide analytical insights, this section displays the precise number of days tracked and the distribution of sleep quality as submitted by the user. The page is tastefully divided into two graphic representations: a pie chart that classifies sleep quality and a bar/line chart that shows how long users sleep for each night logged. Below this, a thorough sleep log table lists individual records, providing a more in-depth look at daily entries. By providing users with an accurate assessment of their sleeping patterns, this transparent approach promotes awareness of one's sleep habits without the use of interpretive analytics.

Figure 13 - History Page Information

This feature provides a macro and micro insight of sleep trends through a visually plotted dynamic graph displaying the user's duration of sleep over time.

1a. Graph Points and Timeline: Dates are shown prominently along the x-axis of the graph, which is anchored by a timeline of sleeps. Users can see a details of their sleep on specific nights by hovering over various points on the graph, which displays the number of hours of sleep for that night. In addition to increasing user engagement, this interactive feature offers, at a comprehensive glance meaningful sleep information.

1b. Graph Customization: Sleep.io allows the graph to be changed from a line chart (a) to a bar chart (b) while keeping the user experience front and centre. Users can view their data in a way that best supports their interpretation thanks to this customisation. The platform's user-friendly approach is highlighted by the flexibility to switch between visualisations, which caters to a variety of tastes in data engagement.

a). 

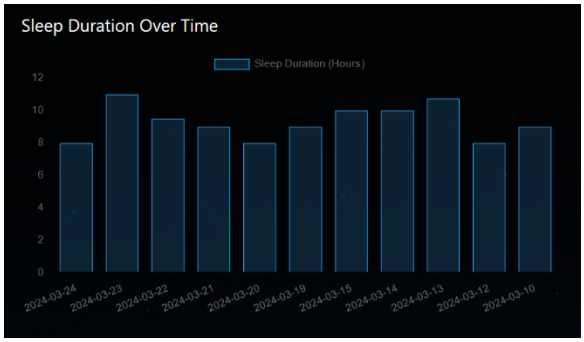
b). 

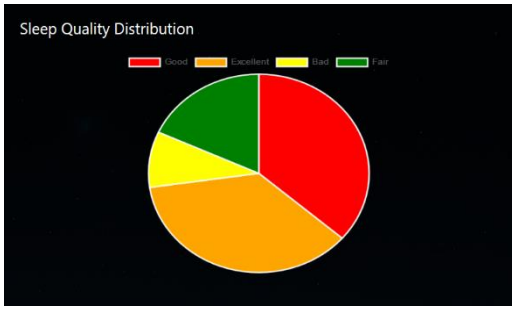
Figure 14 - Duration graph details.

Feature 2: Sleep Quality Distribution Chart

On the right of the screen, we find the Sleep Quality Distribution chart, a vivid pie chart that details the composition of the user's sleep quality.

2a. Quality Pie Chart: The pie chart divides the user's sleep quality into distinct colours that correspond to varying levels of quality, providing a visual summary of the user's sleep(a). This visual segmentation highlights the user's most frequently encountered sleep quality and gives a clear, instant comprehension of the distribution of sleep quality. It's important that users can understand their sleep quality distribution at a quick glance.

2b. Interactivity with Sleep Qualities: By selecting the options from the drop-down list(b) below allows users to explore each quality category in more detail. A bar chart-style percentage breakdown of that particular quality is responsively provided by the application(c). In addition to providing specific insights on sleep patterns, this interaction improves user involvement and makes data exploration easy to understand and educational.



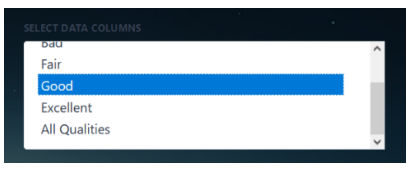


Figure 15 - Example of Quality Chart Change

Feature 3: The Sleep Record Table

a). When '*All Qualities'* are selected Pie chart appears → b). Drop down list for selecting quality options. → c). Individual display of selected qualities.

Moving from the clear but general overview of sleep data: the sleep record table on Sleep.io is a vital component for tracking sleep trends, providing users with a detailed, chronological log of their sleep history. This archive is crucial for identifying patterns and guiding improvements in sleep habits, enabling informed decisions for better sleep health.

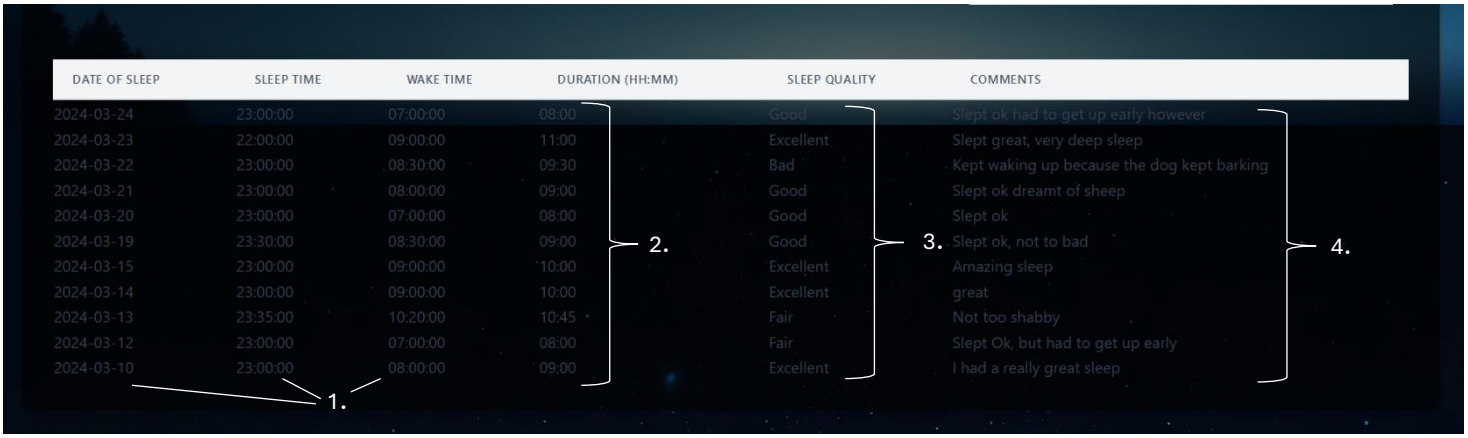


Figure 16 - Sleep History Record Table

1. Date of Sleep, Sleep Time, and Wake Time: Sleep.io's sleep record table is meticulously arranged in the order of entry, guaranteeing that users are always welcomed with their most up-to-date sleep log. This careful design is essential as it enables users to quickly assess their most recent sleep patterns, thereby encouraging an immediate understanding of their rest cycles. The start and end of each night's sleep are recorded by users, providing crucial information for the platform's analytical algorithms. The table's design features a clean, grid-like appearance that makes it easy to read and helps users keep track of their sleep schedule. Sleep.io's dedication to a smooth and simple user experience is exemplified by the way this user-friendly design is integrated with the practical necessity of chronological tracking.

2. Duration: The table from Sleep.io seamlessly reduces user input by calculating sleep duration automatically. This feature offers users the convenience of knowing how long they've slept for each night without requiring them to perform manual entry or computation.

3. Sleep Quality: The subjective aspect of sleep tracking on Sleep.io, where users qualitatively evaluate their nighttime rest, is recorded by the sleep quality column. Through assigning a score ranging from 'Excellent' to 'Poor,' users add a personalize quality to their sleep data. This feature is essential in formulating the users overall sleep score.

4. Comments: One important aspect of Sleep.io is its comments table, which lets users highlight special sleep experiences or disruptions that are difficult to record with only quantitative data. Users can record variables that affect their quality of sleep, such as stress, nutritional changes, or environmental disturbances, in this personalised commenting space.

The Profile Page(6)

Users' profile pages on Sleep.io functions as an individualised dashboards that compiles important sleep metrics in one place. With the goal of promoting healthy sleep habits, the profile page provides personalised information on the quantity, quality, and consistency of sleep. The profile page aims to supply users with the information they need to make sound choices for improved sleep health by offering personalised insights and practical solutions.

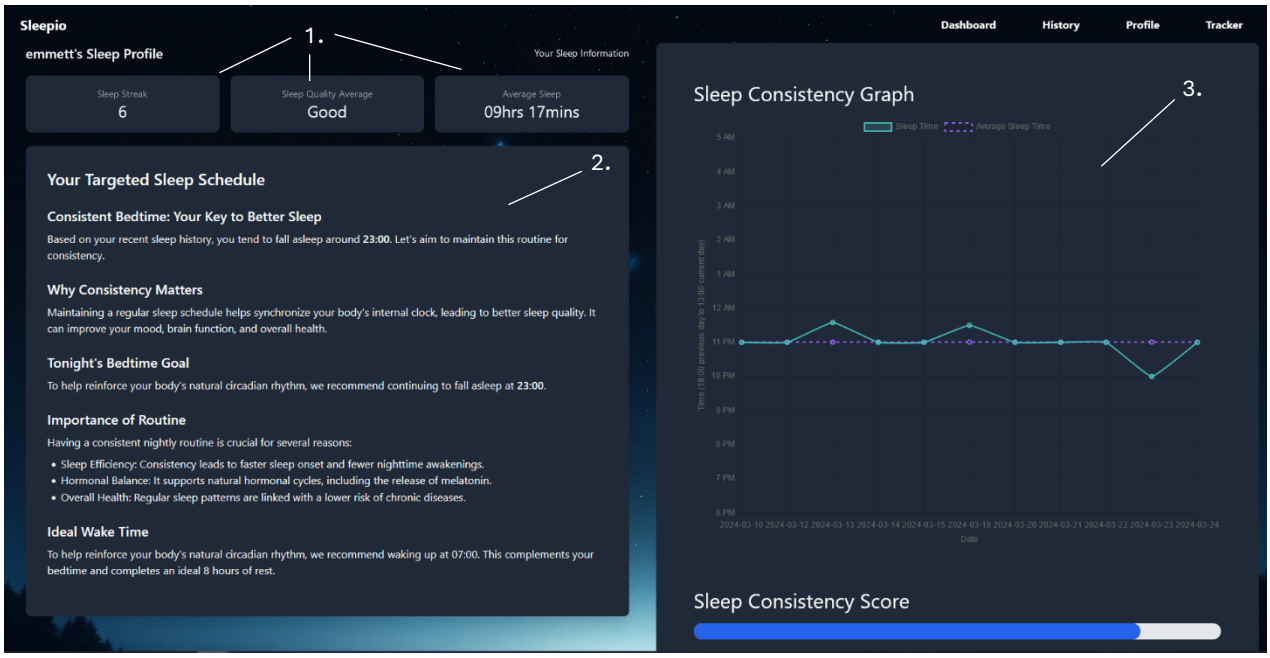


Figure 17 - The Profile Page Overview

1.Personalize Sleep Widgets

Figure 18 - Sleep Widgets

1a. Personal Title: The user's experience is quickly personalised by Sleep.io's profile page, which prominently shows '[Username]'s Sleep Profile'. By adding a personal touch, the user and their data become more connected, emphasising that the suggestions and information are exclusively theirs. Personalization can increase user engagement, as seeing one's name attached to the sleep data reinforces the sense that this health journey is a personal one.

1b. Sleep Streak: To provide users with inspiration, the 'Sleep Streak' widget counts the number of days in a row that they have followed their sleep routine. By visually reflecting their accomplishments, it encourages users to keep regular sleep schedules.

1c. Sleep quality Average: The 'Sleep Quality Average' provides users with a summary of their general level of sleep health. This metric is essential because it condenses complicated data into a digestible manner, enabling users to quickly evaluate the quality of their sleep at a glance.

1d. Average Sleep: To highlight the user's usual sleep duration, the 'Average Sleep Duration' is essential. It's a crucial element since getting enough sleep is associated with several health advantages, and users are more likely to consistently accomplish their sleep objectives when this data is readily available.

The availability of readily accessible, personalized sleep data is crucial in fostering an informed approach to sleep health. I wanted this to help users to assess their patterns of daily sleep easily, recognise long-term trends, and modify their routines in a timely manner. The basis of overall well-being is getting optimal sleep, which is made possible by this clear and concise display of important sleep metrics.

2. Importance of Sleep Consistency Section and Information

I wanted to stress the value of consistent sleep habits when I designed the "Your Targeted Sleep Schedule" section. The information in this portion explains how important it is to maintain a regular sleep schedule to synchronise the body's internal clock, which can enhance both the quality of sleep and general wellbeing. It is ensured that users may quickly understand the principles and the reasons behind the suggested sleep and wake-up goals by presenting this information clearly. I make sure that consumers get the information they need to get the best possible sleep-in addition to assistance by incorporating these insights into the design.

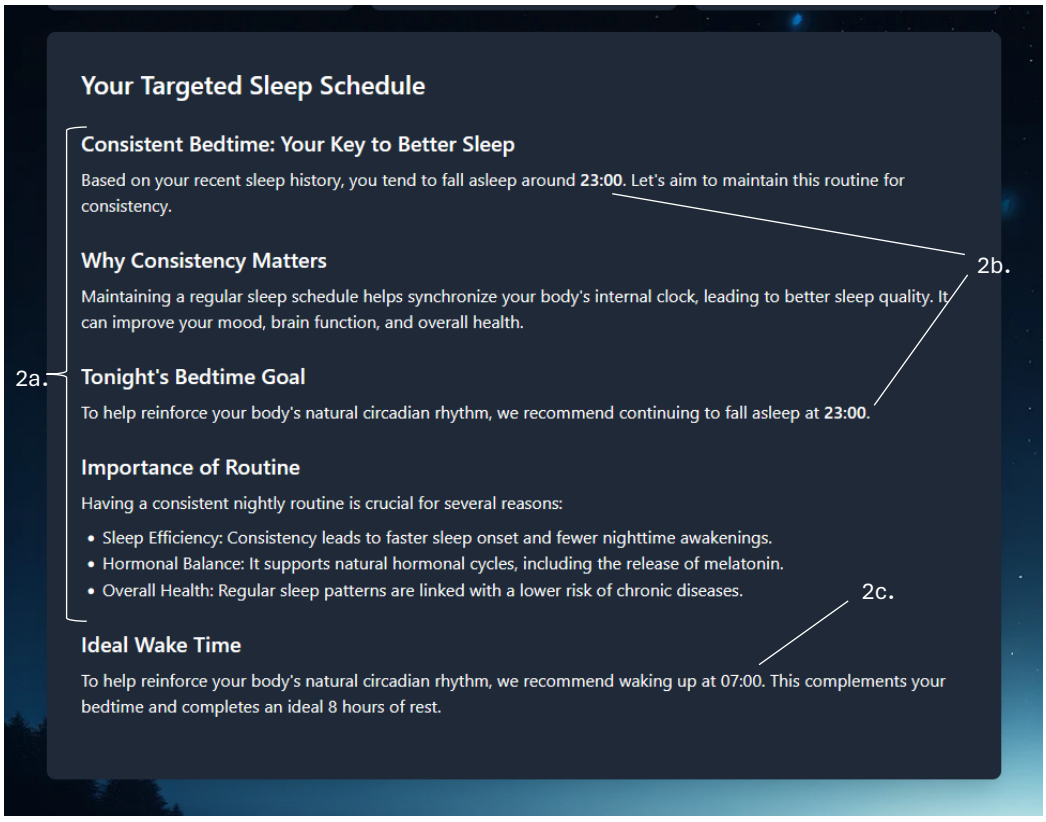


Figure 19 - Sleep Consistency Information

2a. Consistency information: My goal was to clearly explain to users why maintaining a regular sleep routine is so important. To communicate the impact of normal sleep patterns on numerous aspects of well-being, I made sure the titles and the explanations that went with them were clear and educational. It was essential to highlight the many advantages of consistency, including better sleep efficiency, hormone balance, and general health. My goal in organising this information was to help people understand how closely our sleeping patterns relate to our daily functioning.

2b. Suggested Sleep Times: The dynamic suggestion of a '23:00' bedtime is a personalized feature based on the user's sleep data. When crafting this feature, I thought about the importance of creating a tailored experience. My goal was to encourage users to achieve their ideal sleep pattern by maintaining a consistent bedtime. This personalized suggestion considers the user's historical sleep data to promote a habit that could be realistically integrated into their routine. This can be seen in section 3, the consistency chart.

2c. Suggested Wake Times: My primary focus was how sleep and wake times are related. To guarantee that users can complete an 8-hour sleep cycle, the dynamic wake-up recommendation of '07:00' is computed. I wanted to emphasise how important it is for the user into having a full good night's sleep. By automating this suggestion, users are relieved from having to calculate their ideal wake-up time, simplifying their journey towards improved sleep hygiene.

3. Sleep Consistency Graph

In designing the Sleep Consistency Graph for Sleep.io, my focus was on creating a visual tool that could effectively communicate the user's sleep patterns. I recognized the power of visualization in UI design in interpreting raw data into a clear narrative. By plotting sleep times against dates, it gives users an immediate sense of their sleep habits, making it easier for them to spot inconsistencies and trends at a glance. My goal was to make this complex data comprehensible and actionable, aiding user in their pursuit of healthier sleep habits.

Figure 20 - Consistency graph.

3a. The Sleep Consistency Graph: When I developed the Sleep Consistency Graph, I wanted to ensure that the power of visual learning was at the forefront. It was important to me that users could see, not just read, the regularity of their sleep habits. This graph is the heart of the profile page—a clear, user-friendly interface that translates sleep data into an understandable pattern. In my design, I included a dotted line to represent the average sleep time, providing users with a benchmark against which they could measure their daily sleep times. I considered every element, from the colours to the scale, to ensure the graph was not only informative but also aesthetically pleasing, encouraging regular interaction. This design

choice was about giving users the tools to visually track their progress and make informed decisions to improve their sleep consistency.

3b. The Sleep consistency Score: My goal while creating the Sleep Consistency Score feature was to condense the user's regularity of sleep into a single, understandable number. The score is the result of complex algorithms operating in the background displayed simply. Because of its visual impact, I went with a metered bar, which lets users know immediately where they fall on a scale of sleep regularity. This score acts as a motivational tool by providing an immediate indicator of progress and motivating users to adopt more regular sleep schedules. As a visual cue to progress, the bar moves in and out of reaction to their routines. These imperceptible UI signals have the power to encourage people to adopt healthy habits.

3.3 System Architecture and Functionality

3.3.1 System File Structure

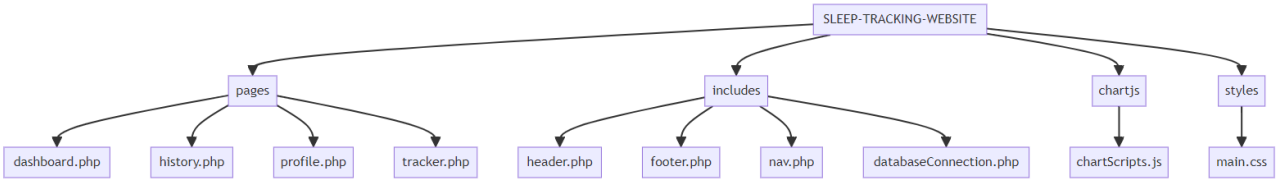


Figure 21 – Simplified File Structure Tree Diagram

This diagram (Figure 17) outlines the principal architecture of the application, detailing the organization of major directories and pivotal files. I've designed this diagram to give an immediate grasp of the project's layout, highlighting essential directories like 'pages' for the various content of these pages, 'includes' for reusable PHP includes such as headers and footers, database connections and more, and 'chart.js' where the JavaScript for data visualization is encapsulated. The 'styles' directory is also noted, containing the main CSS files that are critical for the consistent visual theme throughout Sleep.io. For a thorough account of the complete file structure, which offers an in-depth view of every directory and file within the project, please refer to Appendix A – A2.

Carefully structuring the file structure is essential when I was building Sleep.io. It provides a user-friendly interface and offers clarity to the development process. Common 'includes', including ‘nav.php’ for navigating and ‘sessionconnection.php’ for managing user sessions, logically link pages like ‘tracker.php’ and ‘history.php’. Its structure makes the platform and its coding easy to navigate for myself which is crucial for maintainability and scalability.

3.3.2 Front-End Development

The catalyst of my front-end development was through use of the (TailWindCSS, n.d.)and basic CSS. In this section, I explore the strategic implementation of Tailwind CSS complemented by custom styling to achieve a seamless and consistent user interface across Sleep.io. The choice of Tailwind, a utility-first CSS framework, provided a solid foundation for rapid development and a cohesive look, while custom CSS addressed the unique design requirements of individual pages. This introduction will lay the groundwork for the following discussion, illustrating how this dual approach facilitated the efficient translation of design principles into a functional and aesthetically pleasing user experience. By delving into specific examples and reflecting on the decision-making process, I aim to provide a comprehensive understanding of the methodologies that contributed to the robust and accessible front-end architecture of Sleep.io.

Tailwind CSS for Consistency

Incorporating Tailwind CSS into the development of Sleep.io was a decision that significantly streamlined the process of ensuring design consistency across the platform. The utility-first approach of Tailwind made it straightforward to maintain uniformity in the styling of textual elements and interactive components throughout the application.

Given the health-focused nature of the site, the fonts on Sleep.io needed to convey clarity and comfort. Using Tailwind, I could uniformly apply font classes to elements such as the navigation bar, page titles, and body text across various pages.

```
<! -- HTML Pseudocode for Consistent Tailwind CSS Button Styling -->

<a href="registration.php" class="bg-blue-500 hover:bg-blue-700 text-white font-bold py-2 px-4 rounded">Register</a>

<button type="submit" name="login" class="bg-blue-500 hover:bg-blue-700 text-white font-bold py-2 px-4
rounded">Login</button>

<button type="submit" class="bg-blue-500 hover:bg-blue-700 text-white font-bold py-2 px-4 rounded">Submit Sleep
Data</button>
```

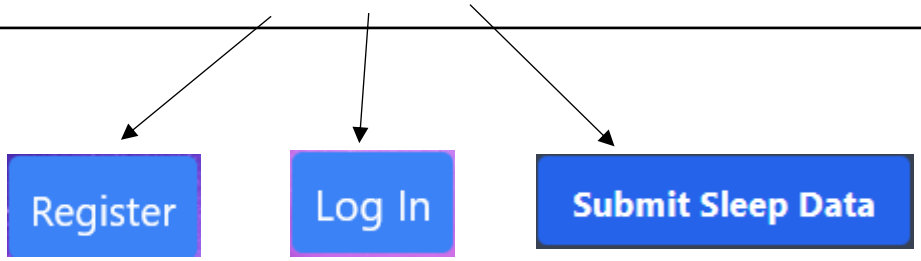


Figure 22 - Consistent Button Styling Across Login, Registration and Tracker Pages - This image demonstrates the uniform appearance of interactive buttons, highlighting the cohesive user interface facilitated by Tailwind CSS.

This HTML pseudocode showcases the application of Tailwind CSS for styling buttons on Sleep.io. By applying a consistent set of Tailwind utility classes, such as ‘bg-blue-500’ for background, each button maintains a uniform appearance that enhances the cohesive design of the website. The ‘text-white’, ‘font-bold’, ‘py-2’, ‘px-4’, and ‘rounded’ classes ensure that all buttons not only share the same style but also provide clear and engaging user interactions. This uniformity in design elements across different pages facilitates a seamless user experience, reinforcing brand identity and usability. For a detailed breakdown of each button's specific properties, please refer to the appendices – Appendix A3.

FontAwesome CSS for Icon use

I decided to use the (FontAwesomeCSS, n.d.)package when developing Sleep.io to provide eye-catching icons to the user interface. These additions not only boost the aesthetic appeal but also navigation and user engagement. This choice was motivated by FontAwesome's huge icon set and versatility, which enable a visual language that is constant throughout all pages. Icons are used to help communicate information clearly and to improve user interaction's efficiency.

The user interface of Sleep.io has been greatly improved by the usage of FontAwesome icons. These icons work as helpful guides for users as they navigate the website, in addition to being purely aesthetic aspects. I improved the overall user experience by making ensuring that the site's functional and aesthetic elements were in harmony by standardising the usage of icons.

Individual CSS for Page-Specific Elements

In developing Sleep.io, I initially employed Tailwind CSS across the platform to ensure a unified and cohesive user interface. This framework facilitated the consistent application of

design elements such as fonts, colours, and layout structures. However, as I delved deeper into the unique functionalities of specific pages, such as the tracker page, it became evident that a one-size-fits-all approach to CSS would not suffice. This can be seen in multiple pages, notable the tracker – due to this page's unique widgets and features, the profile and history page – although they are similar in format and visually consistent due to information presentation differences, they each have unique CSS that must be individualise to them.

For example, within the tracker page manual CSS was developed on the page to create specific designs:

```
<div class="chart-container flex-grow flex justify-center items-center mb-8 lg:mb-0">
    <?php include 'wakeTimesChart.php'; ?>
</div>
```

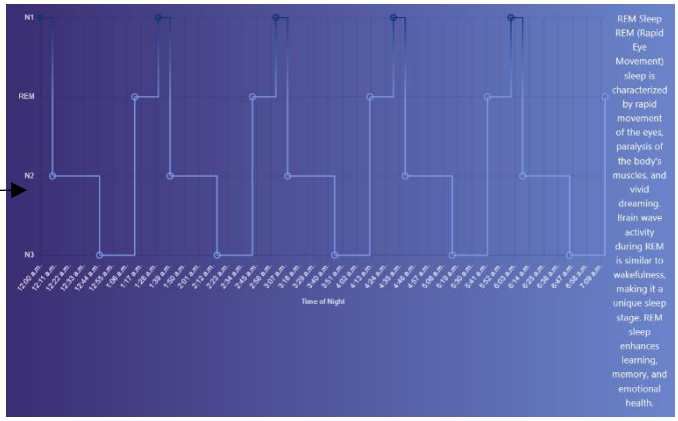


Figure 23 - Basic Sleep chart without styling.

```
/* Pseudocode for sleep info and chart containers */

.chart-container {
    background-color: rgba(255, 255, 255, 0.1);
    border-radius: 15px;
    box-shadow: 0px 4px 10px rgba(0, 0, 0, 0.5);
}

.sleep-info-container {
    background-color: #202020;
    border-left: 2px solid #7597de;
}
```

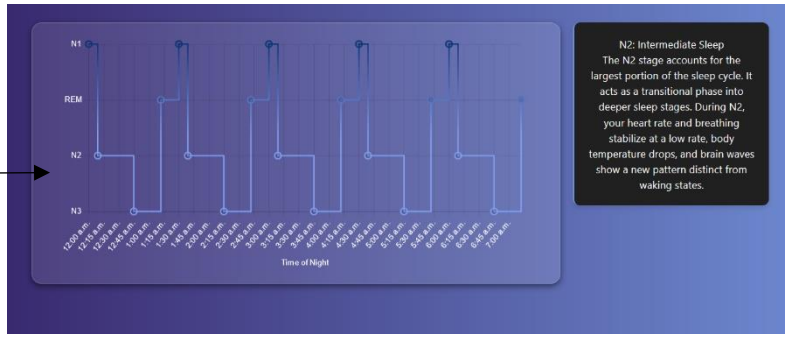


Figure 24 - Enhanced sleep chart with additional Styling.

3.3.3 PHP and Data Processing

In building Sleep.io, PHP played a critical role in handling the data from user inputs on the tracker page, storing it in the database, and then retrieving it for use across the site. My objective was straightforward: capture user input reliably, process it, and present it in a meaningful way, which is especially evident on the tracker, history, and profile pages.

PHP was key in creating personalized experiences. It allowed me to write functions that turned simple data entries into tailored sleep insights. As we explore further, I'll explain how PHP made it possible to not just collect user data but also to transform it into the detailed reports that users see on Sleep.io. This behind-the-scenes work was complex, but it's crucial for providing the customized feedback that makes the site valuable to its users.

Login Mechanisms and Session Management

The session() function in PHP is a critical feature for Sleep.io, as it creates a personalized and secure environment for every user. It enables the website to recognize users across different pages, preserving their login state and ensuring that their interaction with the site is seamless. This function underpins the login process, linking user credentials with their active session, which is pivotal for maintaining accessibility and privacy throughout their visit to Sleep.io. The login functionality on Sleep.io is built with PHP to manage user authentication

and maintain their session across the website. Once users log in, a session starts, carrying their details through different pages without the need to log in again. This is crucial for a personalized and secure user experience. Since the session() function begins the ‘sessionconnect.php’ file – the file that holds database connection details – and that this file is at the beginning of every page in ‘Sleep.io’ all pages always are using ‘session()’.

The PHP logic for this, detailed in the appendix, is vital for secure and smooth navigation. It includes error handling and security measures to protect user data. The 'sessionconnection.php' file is integral to this, ensuring consistent user sessions throughout Sleep.io, enhancing both usability and security. Please refer to the Appendix for a more detailed breakdown – Appendix A4.

Data Handling Logic for Sleep Form

The form processing script is the engine behind user data submission in Sleep.io. It acts as the crucial bridge between the user's input on the frontend and the application's data handling on the backend, ensuring that user-provided sleep data is accurately captured, stored, and ready for subsequent analysis.

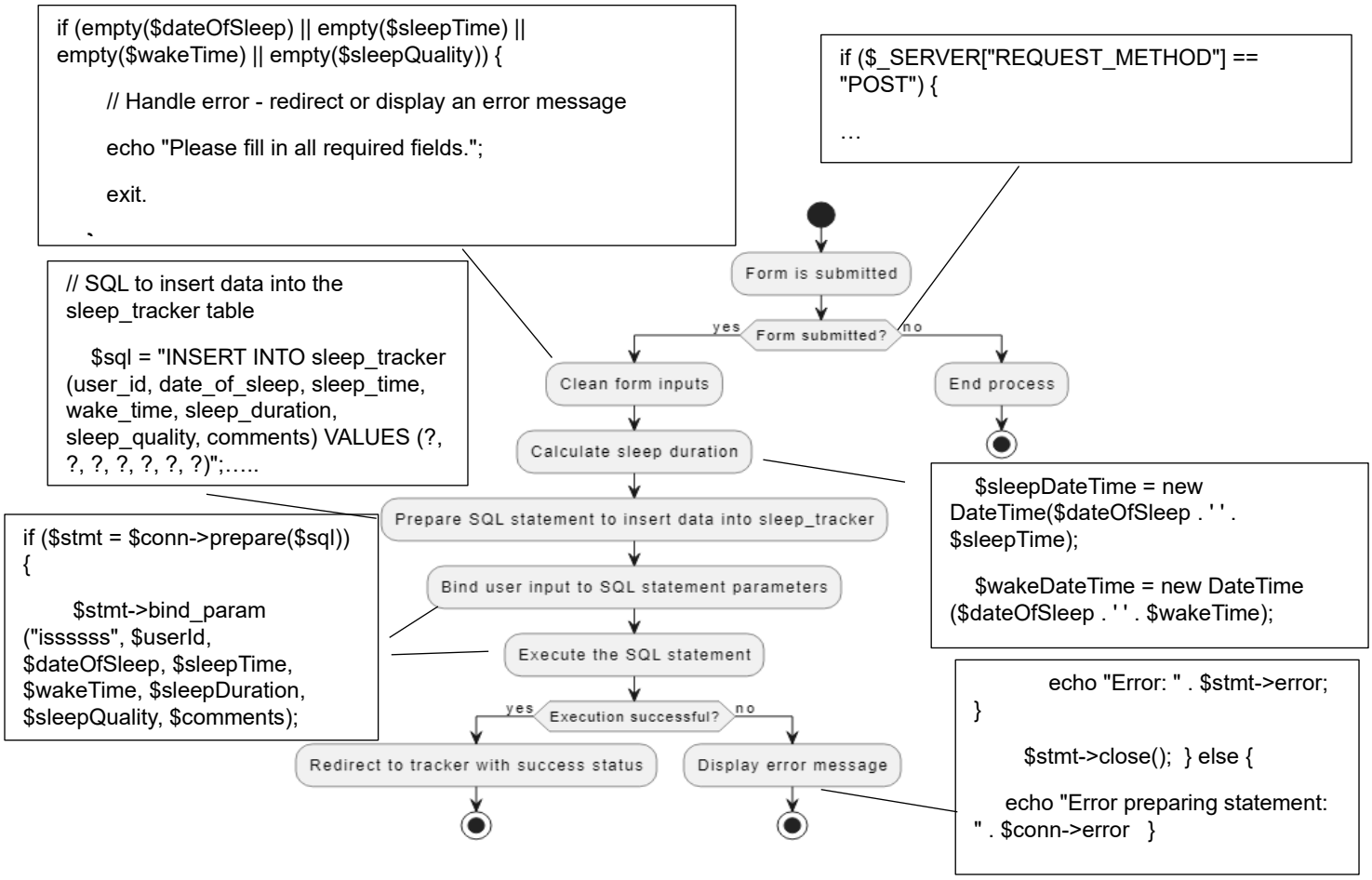


Figure 25 - Form Submission code explanation.

In managing the form data submitted by users, I engineered the PHP script to not only collect but also intelligently process the sleep information. For instance, while the form itself does not explicitly ask for 'sleep duration', this value is crucial for analysis and so, its calculated within the script. This automated calculation signifies efficient coding practice, eliminating the need for manual input which could lead to user error and variability.

Data Flow and Database Importance

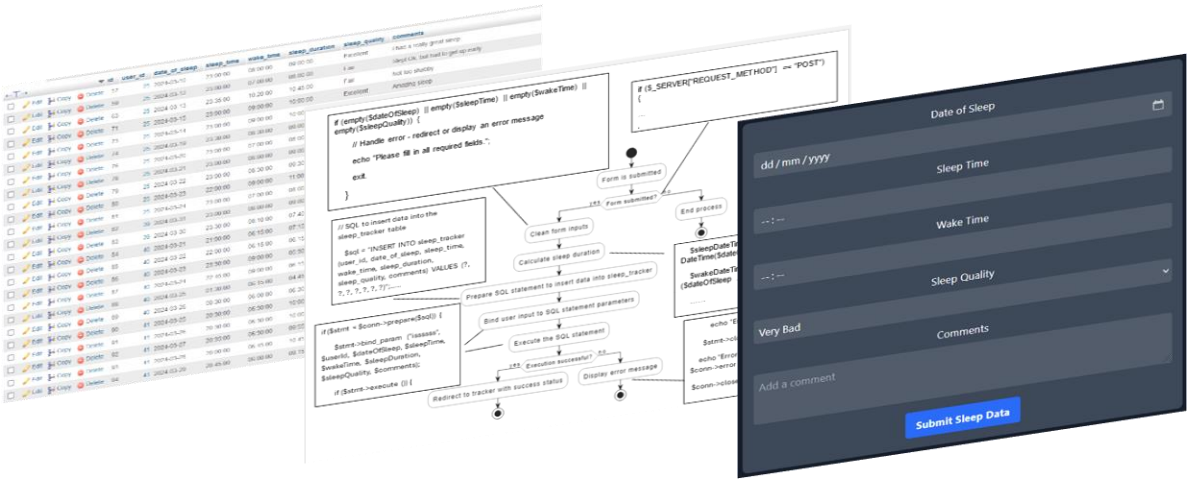


Figure 26 - Visual aid of how front-end tracker form interacts with the back-end database use PHP and SQL logic

This process involves meticulous PHP scripting to handle form submissions, ensuring data is not only captured accurately but also integrated smoothly into our system. The importance of this seamless integration cannot be overstated, as it directly impacts user satisfaction by providing immediate, error-free feedback and results based on their input.

The backend—the database—plays a pivotal role in organizing this data effectively. Well-organized storage is crucial for efficient data retrieval, scalability, and ultimately, the performance of Sleep.io. It's here that well-structured PHP code comes into play, ensuring that data not only enters the database correctly but is also maintained securely, adhering to best practices in data management.

Database Structure and Table Discussion

Next, let's examine the structure of our database, focusing on how we store and manage the sleep data collected. I'll present a diagram of the database schema, highlighting key tables and their relationships, with a special focus on the 'sleep_tracker' table, which is central to storing user-submitted sleep data.

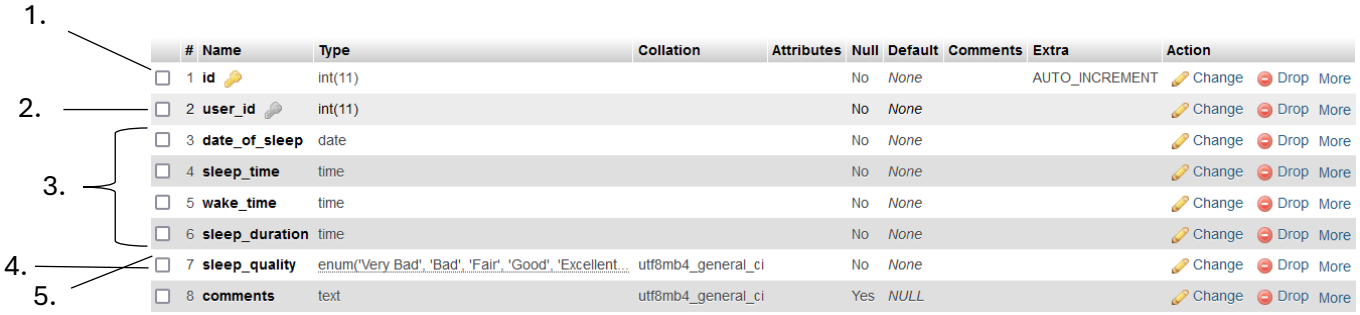


Figure 27 - Database structure.

1. ID(Primary Key): Each record in the 'sleep_tracker' table is uniquely identified by an 'id', a column set to auto-increment. This design choice simplifies the process of adding new records and ensures that each entry has a unique identifier. This primary key is crucial for indexing, optimizing data retrieval and update.

2. User ID(Foreign Key): The 'user_id' acts as a foreign key, establishing a link between each sleep entry and a specific user in the 'users' table. This relational touchpoint is the cornerstone of personalized user experience, allowing Sleep.io to display and analyse sleep data pertinent to the logged-in user, maintaining data integrity and enabling user-specific insights.

3. Date of Sleep, Sleep Time, Wake Time, and Sleep Duration: The 'date_of_sleep', 'sleep_time', and 'wake_time' are timestamps provided by the user, reflecting the chronology of their sleep pattern. The 'sleep_duration', calculated by backend logic, quantifies the total sleep time, translating raw timestamps into meaningful metrics.

4. Sleep Quality: Enumerated as 'sleep_quality', this column holds user-assessed sleep quality. With options ranging from 'Very Bad' to 'Excellent', this field allows users to qualitatively describe their rest. This subjective data, when cross-referenced with quantitative metrics, provides a comprehensive view of sleep health and is instrumental in tailoring health recommendations and insights.

5. Comments: The 'comments' text section allows users to add any more notes or remarks regarding their sleep session. Users can enter contextual data through this open-ended input, which gives them a place to report variables that may impact sleep but are not covered by structured data fields. These qualitative contributions can provide invaluable insight when analysing data or conferring with healthcare professionals.

Data Processing and Output in Sleep.io: PHP's Role

PHP's integration with the backend was essential in creating Sleep.io since it allowed for the conversion of unprocessed user data into insightful and useful information. I was able to develop functions that take input data and then compile it into customised analytics for each user by utilising PHP's powerful server-side scripting features.

Dynamic processing in PHP is excellent at providing a customised user experience. Using specially designed PHP functions, the platform analyses sleep durations, patterns, and quality to provide users with a comprehensive and illuminating view of their sleep behaviour. PHP-powered backend complexities work in unison to deliver a user experience that makes complex data easy to understand and navigate. Constantly, the aim was to guarantee that each user.

The Use and Importance of ‘sleep_data_display.php’

In the heart of Sleep.io's functionality lies the 'sleep_data_display.php' file, a central repository where the essence of our sleep-tracking logic resides. This file is instrumental in aggregating user data and transforming it into meaningful analytics. My role in its creation was to distil complex sleep patterns into accessible insights, allowing users to grasp the nuances of their sleep cycles readily.

Within 'sleep_data_display.php,' essential functions transform sleep data into meaningful insights:

- calculateSleepScore(): Assigns a score to reflect sleep quality, providing a quick reference for users to assess their restfulness.
- getLastSleepDuration(): Retrieves and displays the duration of the last sleep session, allowing users to monitor their sleep length. (Used in *figure 15 -label 2*)
- getLatestWakeTime(): Captures the most recent wake-up time to help users understand their waking patterns. (Used in *figure 7 -label 3b*)

- calculateSleepStreak(): Encourages consistency by tracking consecutive days of sleep logging, motivating users to maintain a stable routine. (Used in *figure 7 -label 3b*)
- getSleepQualityAverage(): Averages sleep quality ratings to give users a long-term view of their sleep health. . (Used in *figure 17 -label 1b*)
- getSleepTimeAverage(): Calculates the average amount of sleep, offering insights into overall sleep quantity trends. (Used in *figure 17 -label 1c*)
- getAverageBedtime(): Suggests an optimal bedtime based on past data to promote regular sleep schedules. (Used in *figure 18 -label 2b*)

Each function not only reports on sleep metrics but also actively engages users, guiding them toward better sleep habits and overall well-being. These algorithms encapsulate the philosophy of turning data into actionable knowledge, fostering a proactive approach to sleep management. An in-depth look at how all these codes function can be seen in the Appendix - A1.

'sleep_data_display.php' has several functions that are particularly noteworthy due to their influence on user engagement and data interpretation in the goal of personalised sleep analytics. I will explore the inner workings of one essential function: calculateSleepScore(). As I feel this function is the most complex, important and is essential to understand to know in depth how ‘Sleep.io’ functions.

How ‘calculateSleepScore()’ functions

1. Initialization and Data Retrieval: The function begins by setting the initial sleep score to zero and retrieving the latest sleep entry for the logged-in user, ensuring calculations are based on the most current data.

2. Data Processing: If data is present, it's processed to check validity and prepared for scoring.

3. Score Calculation: Sleep quality is converted to a numerical base score, which is then adjusted by the sleep duration through specific multipliers.

4. Bonus Application: An additional bonus is awarded for optimal sleep conditions, promoting better sleep habits.

5. Final Adjustments: The final sleep score is adjusted to fit within established quality ranges and rounded for presentation.

Because it combines sleep time and quality, the Sleep.io sleep score is essential for providing a comprehensive picture of an individual's overall sleep health. The score accurately captures the relationship between sleep length and quality by including duration modifiers and quality ratings. This dual focus encourages users to develop better sleep habits in addition to provide a sophisticated measure that helps users understand their sleep patterns. It's intended to motivate users to maximise their sleep's quantity and quality to improve their general wellbeing. Refer to the Appendix A6 for a more detailed breakdown.

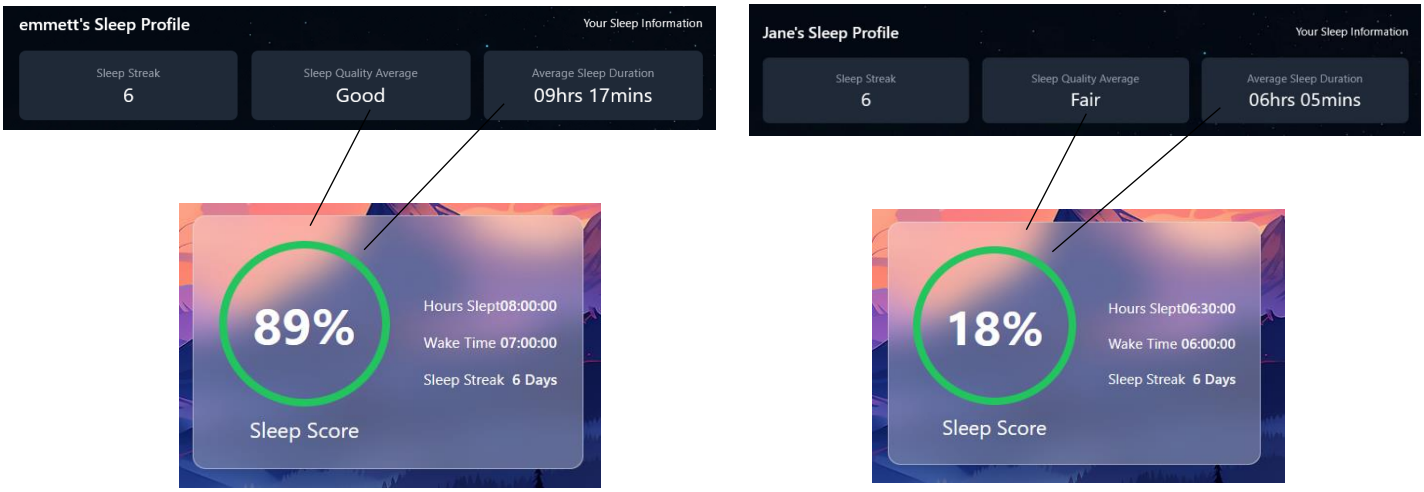


Figure 28 - Comparison showing how different sleep statistics show the sleep score outcome differently.

Consistency Chart

The next major component in data output within Sleep.io is the sleep consistency chart. This visualization plays a crucial role in helping users understand and improve their sleep habits by clearly depicting their sleep and wake patterns over time. The consistency chart not only makes it easier to spot irregularities in sleep routines but also reinforces the importance of regular sleep schedules—a key factor in overall sleep quality. Let's dive into how this chart functions and why it's an invaluable tool for anyone looking to achieve better sleep health.

Let's break down how this chart gets it information. Stored in the 'consistencyChart.php' file is the sleep consistency chart and this PHP function. Here's important snippets to better understand the sleep consistency chart and how it works:

1.Data retrieval

The initial step involves fetching the sleep data from our database. This process is crucial as it forms the foundation of the chart.

It orders the records in ascending order and retrieves that sleep times and dates stored for later use to plot on the graph.

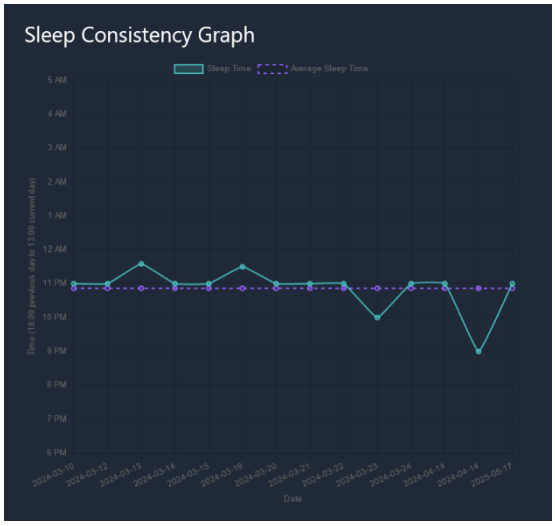
2.Data processing

Next, each sleep time is converted into a decimal format, making it suitable for graph representation. This conversion is important for plotting in Chart.js, where numerical values along the y-axis represent sleep times. Adjusting times that span past midnight ($timeAsDecimal) ensures that the visualization accurately reflects the user's sleep cycle, enhancing the utility and accuracy of the chart.

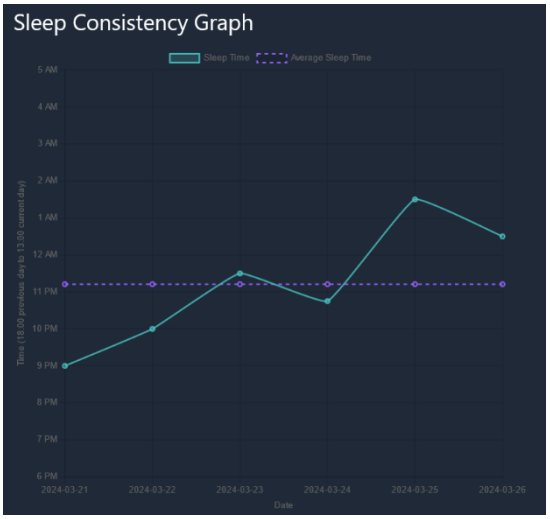
3. Average Calculation

After this, the code computes the mean of all recorded sleep times, which can then be provided as the user's typical bedtime. Displaying this average on the chart helps users visually assess their consistency relative to their average, promoting better sleep habits through self-awareness.

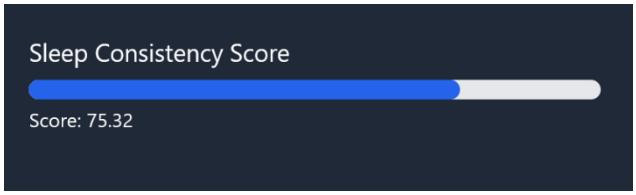
1a)



2a)



1b)



2b)

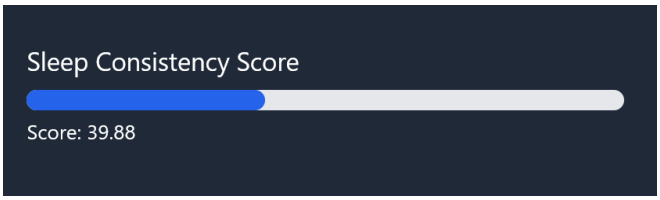


Figure 29 - Comparisons in Sleep consistencies.

We can see a clear correlation between the calculated sleep consistency scores and the regularity of sleep patterns by comparing the sleep consistency graphs ‘1a’ and ‘2a’ with their matching scores in ‘1b’ and ‘2b’. A more regular sleep pattern is shown by the close clustering of the sleep periods in graph ‘1a’ around the average sleep time line. As seen in ‘1b’, a higher sleep consistency score reflects this regularity. On the other hand, graph ‘2a’ shows more variation in the periods that users went to sleep, which results in a lower sleep consistency score, as seen in ‘2b’**.**

Creation of the Hypnogram Data.

The 'SleepChartData.php' file comprises several key functions that collectively fetch, process, and visualize sleep data. Its primary objectives are to accurately determine the distribution of various sleep stages (like REM and N3 sleep) and to provide a graphical representation that users can easily interpret.

How Its broken down:

1. **Data Retrieval:**
    - The getLatestSleepData() function retrieves the latest sleep entry for a user, ensuring that the hypnogram reflects the most current data. This is critical for providing users with relevant and timely insights into their sleep habits.
2. **Sleep Stage Calculation:**

- calculateSleepStages() takes user input for sleep and wake times and quantifies how much time is spent in each sleep stage. This calculation considers the quality of sleep, which influences the proportion of each cycle spent in light, deep, and REM sleep. For instance, a night rated as 'excellent' might show increased periods of REM and deep sleep, reflecting restorative sleep.

3. **Percentage Calculation:**

    - After determining how sleep is distributed across different stages, calculateStagePercentages() computes what percentage of total sleep time each stage occupies. This step is crucial for visualizing data in a hypnogram, as it translates raw durations into percentages that can be easily graphed and understood.

Consistency and Cohesion in Graph Implementation through Chart.js

Chart.js is a powerful and versatile library used in Sleep.io to convert complex datasets processed by PHP into dynamic and interactive charts. This section will explore how Chart.js works in conjunction with the prepared PHP to visually represent user sleep data, enhancing the interactivity and accessibility of the platform.

Developing the HTML in a separate file and later integrating it has streamlined the process of maintaining and updating the visualization features of Sleep.io. By isolating the <canvas> tag in its own environment, it simplifies the dynamic integration of Chart.js with the PHP backend. This separation allows the PHP scripts to efficiently prepare and deliver data directly to the canvas. More detail in appendix A7

```
const chartData = <?php echo json_encode($phpProcessedData);
?>;

const ctx = document.getElementById('myChart').getContext('2d');

new Chart(ctx, {

  type: 'line', // or 'bar', 'radar', etc.

  data: chartData,

  options: {...}

});
```

As seen here, the prepared data from PHP is dynamically fed into Chart.js, which is configured to render this data on a **<canvas>** element. This approach allows for the creation of responsive and interactive charts that effectively visualize complex sleep patterns, making it easier for users to understand and engage with their sleep data.

Figure 30 - Pseudo Code for Chart.js feature

3.4 Ethical Design Considerations

Sleep.io's development is guided by an ethos which puts an emphasis on user privacy and the secure management of individual sleep data. Sleep.io is committed to data security, as seen by the way we protect each user's data with password safeguards and unique user IDs. Furthermore, by offering generalised forecasts, Sleep.io avoids potential biases relating to age, gender, or ethnicity and guarantees a consistent user experience. This moral position about the management of data and user interaction is consistent with more general talks about digital ethics, stressing the significance of creating digital tools that uphold user autonomy and guarantee inclusivity. Sleep.io strives to be a responsible digital product that users can trust with their personal health data by putting these ethical design principles into practice.

3.5 Feedback-Driven Refinement

The evolution of Sleep.io's UI was fuelled by a cyclical feedback-driven process, placing user input at the heart of our design refinements. Initial surveys were disseminated to gather baseline user preferences and expectations. As the platform progressed, user testing sessions and beta releases became pivotal, providing real-world insights into how users interacted with Sleep.io.

User feedback was meticulously analysed, with both quantitative data and qualitative insights informing the iterative design process. Usability tests, for instance, revealed the need for larger touch targets on mobile devices, prompting adjustments to button sizes and spacing. This iterative process, underscored by an open dialogue with our users, ensured that the UI not only met but also evolved with user needs and expectations.

Chapter 4: Verification, Validation and Testing

4.1 Introduction to Testing

Black box testing for Sleep.io involves evaluating the application's interface without considering its internal code structure. This approach ensures that the system's functionalities meet user requirements effectively, particularly for critical features like secure login, data processing, and output accuracy. It's an essential part of Sleep.io's development to guarantee a quality user experience.

4.2 Outlining the System Requirements for Testing

In building Sleep.io, we prioritized key user requirements essential for a seamless and functional experience. These requirements cater to the core functionalities that our users expect from a sleep tracking platform:

1. User Registration and Login
2. Data Entry for Sleep/Wake Times
3. Sleep Quality Rating and Comments
4. Sleep Duration Calculation
5. Sleep Score Generation
6. Visualization of Sleep Stages
7. Historical Data Review

To ensure these features effectively meet user needs, we crafted specific test cases for each requirement. Each test case is designed to validate functionality and includes:

Requirement	Test Case ID	Test Case Description	Expected Result	Actual Result	Pass/Fail

This will talk about which user requirement will be covered	this will label which test case it will be for ease of organisation	This will talk about what the test case is attempting to find/do	Here we will talk about what the expected result of the system should be	After we attempt to test we will document what the actual outcome was here	Here we will mark if the test passed or failed

Figure 31 - Black Box test case example.

4.3 Brief Overview of Test cases

Requirement	Test Case ID	Test Case Description	Expected Result	Actual Result	Pass/Fail
User Registration	TC01	Register with valid user details.	User is registered and can log in.	User successfully registered.	Pass
User Login	TC02	Login with correct user credentials.	Access granted to user dashboard.	User logged in and dashboard loaded.	Pass
Enter Sleep/Wake Times	TC03	Input valid sleep start and end times.	System calculates and displays duration.	Duration calculated and displayed.	Pass
Rate Sleep Quality	TC04	Rate sleep quality and add comments for a session.	Input is saved and reflected in session review.	Rating and comments are visible.	Pass
Historical Data Review	TC05	View past sleep data entries on history page.	Display all past entries accurately.	All entries displayed correctly.	Pass

Figure 32 - Overview of test Cases.

In this section, we've taken a brief look at a selection of test cases that were carried out to validate and verify the functionality of Sleep.io. These test cases provided valuable insights into the system's performance and user interaction, highlighting the robustness of the platform and areas for improvement. The feedback obtained from these tests has been instrumental in refining the user experience and ensuring the system meets the defined requirements. For a comprehensive view of all the test cases and the extensive testing process undertaken, please refer to the detailed documentation provided in the appendix.

4.4 Testing insights and Project improvements

I ran into a few serious problems during the testing stage that resulted in system failures. The first had to do with registering as a user. At first, the system let users to register with usernames that had already been taken or with blank spaces. Because almost every Sleep.io function depends on a distinct login to secure and customise the user experience, this issue was important. After realising this problem, I put input validation in place to make sure that before

letting the registration process finish, all required fields are filled out and a username is unique. This enhancement improved data consistency and security and had a significant effect on the integrity of the system.

Another challenge arose when users were able to enter future dates for their sleep entries. This was a challenge because it can result in the storage of erroneous and untrustworthy data, which would distort the analytics and insights offered by Sleep.io. I created a validation check to deal with this, which would reject any dates entered in the future. This correction was essential to preserving the validity and utility of the sleep data. Because of this, users can be sure that the platform's research and suggestions are founded on timely and reliable data.

These two improvements significantly increased Sleep.io's resilience and dependability. I could offer a service that is more reliable and oriented towards the needs of the user by making sure that user registrations are distinct and that sleep data entries are limited to valid dates. These adjustments highlight the significance of extensive testing and the worth of the knowledge acquired from it, as they inevitably result in an improved and more intuitive platform.

4.5 Re-testing and re-analysis

In the retesting phase, we'll revisit the functionalities that previously failed—the registration process and the date input for sleep entries. The objective here is to validate the effectiveness of the implemented fixes.

Requirement	Test Case ID	Test Case Description	Expected Result	Actual Result	Pass/Fail
Registration with blank fields	TC01	Attempt to register with all input fields left blank.	The system should prevent the registration and prompt for mandatory fields.	System prevented registration and prompted for mandatory fields.	Pass
Registration with an existing username	TC02	Attempt to register using a username that is already in use.	The system should prevent the registration and alert the user about the username being in use.	System prevented registration and alerted the user about the username issue.	Pass
Sleep data entry with a future date	TC01	Attempt to input sleep data with a date set in the future.	The system should reject the entry and prompt an error about the date being in the future.	System rejected the entry with an appropriate error message.	Pass
Sleep data entry with the current date as the	TC02	Ensure the date input field does not allow a	The system should limit the date	Date input field correctly	Pass

maximum permissible date		date later than today.	input field to today's date.	restricted to today's date.	

After these specific code improvements were put into practice, a retesting process was started with an emphasis on issues that were previously identified. The successful modifications improved Sleep.io's functionality and user experience. Incomplete registrations are now consistently stopped, asking users to provide missing information, and attempts to register using an already-existing username are promptly rejected. Moreover, the possibility of illogical future date submissions has been addressed by limiting sleep data entries to present or past dates. With these improvements, the site's dependability and integrity has risen, guaranteeing users a seamless and error-free experience. The need of extensive testing and ongoing improvement throughout the development cycle is reaffirmed by this reanalysis.

4.6 Additional forms of testing

4.6.1 Integration and System Testing.

In the development of Sleep.io, the integration and system testing phase was approached with a structured and methodical strategy, reflecting a keen understanding of the intricacies involved in ensuring a seamless, functional system. The initial step in this phase was to solidify the website's layout and design, establishing a robust foundation upon which the system's major elements could be integrated and tested for cohesive operation.

Integration Testing Process

The integration testing process was meticulously planned, beginning with the independent development, and testing of significant components such as the consistency chart, sleep cycle chart, and percentage pie charts. Each component was developed on separate pages to mitigate potential complications and ensure that the integration into their respective final pages—namely, the profile and tracker pages—would not adversely affect existing functionalities. This isolation of components facilitated a focused testing environment where functionalities could be verified in a controlled setting before their system-wide integration.

The testing strategy employed was a hybrid approach, incorporating both top-down and big-bang integration testing methodologies. Top-down integration testing was prioritized for main modules like the consistency and sleep cycle charts, ensuring these pivotal elements functioned flawlessly within the broader system architecture. Subsequently, big-bang integration testing was applied to integrate and evaluate the system's other components, such as the history page and additional functionalities within the tracker and profile pages. This dual-strategy approach, conducted through Visual Studio Code (VSC), allowed for a comprehensive assessment of both individual module performance and their interplay within the system.

Challenges and Solutions

Throughout the integration and system testing phase, challenges predominantly emerged from discrepancies between expected and actual outputs of functions or formulas. A notable example was observed in the formula governing the sleep cycle, which, upon initial testing, did not accurately reflect the anticipated variations in REM sleep duration in response to differing sleep qualities. This discrepancy was attributed to formulaic inaccuracies, necessitating a rigorous process of evaluation and adjustment. The resolution involved meticulous formula

tweaking and correction, underscoring the critical nature of precise algorithmic implementation in achieving the desired system behaviour.

Reflections and Insights

This phase of development underscored the importance of a segmented approach to system integration, where the isolation of components not only simplified testing procedures but also enhanced overall system reliability. The challenges encountered, particularly in formula and function implementation, highlighted the need for an adaptive testing strategy capable of identifying and addressing unforeseen issues.

The integration and system testing phase of Sleep.io stands as a testament to the project's commitment to delivering a robust, user-centric platform. Through the careful orchestration of testing methodologies and the strategic resolution of encountered challenges, Sleep.io emerged as a cohesive system that accurately embodies the envisioned functionality and user experience. This phase not only solidified the system’s operational integrity but also provided invaluable insights into the importance of flexibility and precision in the realm of software development and testing.

4.6.2 User Acceptance Testing (UAT)

In the development of Sleep.io, User Acceptance Testing (UAT) was uniquely tailored to the project's context and constraints, underscoring a creative approach to validating the system's functionality and user experience. Rather than employing a traditional UAT process with external participants, the project adopted a persona-based testing strategy, leveraging three distinct user personas: "Owen the fitness trainer," "Jane the stressed nurse," and "Mike the sleep-deprived student." This innovative approach allowed for a focused exploration of the system's performance across diverse user needs and scenarios, providing valuable insights into potential enhancements and necessary adjustments.

Persona-Based UAT Strategy

The selection of personas was strategic, each representing a segment of Sleep.io’s target user base, with distinct motivations and usage patterns. By embodying these personas, the developer could simulate a range of user interactions with the system, from logging sleep data to interpreting feedback and recommendations. This method of UAT was instrumental in identifying user experience issues and functional bugs that might not have been evident through code-based testing alone.

Challenges and Insights from User Acceptance Testing

Testing with personas such as Owen, a fitness trainer, and Jane, a stressed nurse, revealed critical insights. Owen's tests showed that even with optimal sleep metrics, the sleep score formula needed adjustments to better reflect real achievements, leading to its refinement. Jane's extensive use of the commenting feature uncovered encoding issues, prompting improvements in text processing and display on the history page.

Documentation and Iterative Improvements

Issues were tracked through handwritten documentation, providing a clear and immediate overview of the testing landscape. This organized approach facilitated systematic bug fixes and enhancements, significantly boosting the system's functionality and user experience.

Impact on Development

The persona-based UAT was pivotal in refining Sleep.io's functionalities, allowing adjustments that greatly enhanced user satisfaction and system reliability. This method highlighted the importance of aligning user needs with system performance, exemplifying the value of adaptability and user empathy in software development. Through this innovative testing approach, Sleep.io not only met user expectations but also ensured its readiness for launch.

Chapter 5: Critical Reflection

5.1 Project Overview and Evaluation of Objectives

The beginning of Sleep.io was marked by an ambition to address an important concern—sleep deprivation—through the lens of technological innovation. The idea was to create a tool that goes beyond demographics, providing a universally accessible platform for users to monitor and enhance their sleep habits. This initiative was grounded in the belief that improved sleep quality is a requirement in the broader context of health and productivity enhancement, resonating with the Sustainable Development Goals (SDGs) aimed at promoting well-being.

In response to these goals, Sleep.io was developed, embodying the idea of accessibility and ease in sleep tracking. The tracking, monitoring, and visualisation of sleep data are the main functionalities that the system was developed to handle. This design philosophy reflected the demands of a wide range of users while also being in line with the original goals. By means of rigorous development and iterative refining, Sleep.io managed to fully realise the intended solution, providing a user-friendly and entertaining platform for sleep study.

Important modifications were made to Sleep.io during its development, most notably in the conception and integration of elements such as the sleep cycle chart (Hypnogram). This versatility demonstrated a responsive design process in which choices were made to improve system coherence and user experience. These adjustments highlight the dynamic interaction between the project's original plans and its development's realities, offering insight on its adaptive evolution.

I feel that Sleep.io's user interface stands as a project success. The platform's aesthetic and functional design has I feel achieved the desired feel of professionalism, ease of use, and visual appeal. However, the journey was not devoid of challenges. Areas such as personalized recommendations, while present, revealed opportunities for deeper development and enhancement. This recognition of potential growth areas reflects a nuanced understanding of the project's scope and the inherent limitations faced within the development timeline.

When looking back on Sleep.io's progress, I feel satisfied and see places that I could see further development. In addition to accomplishing the primary goals, the project expanded upon ways in which technology can support our fundamental need for restful sleep. As it successfully combines functionality, user-centric design, and vision, Sleep.io is a notable case study in the use of ICT solutions to improve health and well-being.

5.2 Methodological Insights and Project Challenges

A pivotal technical challenge emerged in the selection and application of data visualization tools. Initially, D3.js (d3js.org, n.d.) was chosen for its diverse capabilities in producing dynamic, interactive visualizations. However, the steep learning curve and time-intensive mastery required for D3.js posed significant hurdles, especially within the constrained timeline of the project. This realization prompted to change to use to Chart.js, a decision

influenced by the tool's more accessible learning curve and its ability to deliver equally compelling visual representations.

The adoption of Chart.js not only alleviated the technical holdup but also expanded the project's visual repertoire. This shift enabled the incorporation of versatile visual elements, such as the ability for users to toggle between bar and line charts on the history page, enhancing user engagement and the overall analytical utility of Sleep.io. This adaptation underscored a vital project insight: the importance of tool compatibility with project timelines and developer skillsets. In retrospect, the initial commitment to D3.js, while ambitious, may have misaligned with the project's temporal and technical realities.

When these experiences are considered, there are important lessons to be learned from the methodological and technological aspects of Sleep.io's development journey. The difficulties faced put the project's adherence to the Waterfall model to the test and brought attention to how important flexibility is when choosing tools and managing projects. These observations highlight the need to strike a balance between ambition and reality and argue for a more flexible approach to methodology and tool selection. If such a project were to be done again, the approach would be to start with a preference for tools such as Chart.js, giving integration simplicity and learning curve concerns top priority from away.

The project also serves as a powerful reminder of the need of careful testing phases and early planning. Investing in these early stages not only helps to avoid potential obstacles and create a clear path, but it can also expedite the development process. Improving the efficacy and dependability of software systems requires a proactive approach to project management and quality assurance.

5.3 Success and Areas for Improvement

Achievements in Design and Functionality

The journey of Sleep.io from concept to reality has been marked by significant achievements that underscore the project's vision and technical prowess. A cornerstone of pride is the user interface (UI) design, which emerged sleeker and more professional than initially envisioned. The aesthetically pleasing and intuitive design stands as a testament to the meticulous attention to detail and commitment to user experience that defined the development process. Another major success was the functionality of the core component of Sleep.io – the tracker page. As the main centrepiece of the site, its successful implementation not only validated the technical approach but also fortified confidence to further expand the platform's capabilities.

Technical Milestones

Achieving a fully functional UI and the tracker page's effectiveness represented pivotal milestones in the project. These accomplishments not only demonstrated the feasibility and potential impact of Sleep.io but also laid a solid foundation for subsequent development phases.

Identifying Areas for Refinement

Even with these achievements, an evaluation points out areas that could use better. One prominent area where adjustments could greatly improve the user experience is with Sleep.io's personalised feedback system. The existing generic feedback tools show how more personalisation and user support may have been achieved, especially in the profile and tracker areas. This acknowledgement provides important context for upcoming stages of development.

Methodological and Technical Insights

The project's development highlighted several key learnings, particularly in project planning and tool selection. The experiences of scaling back ambitious segments and transitioning from D3.js to Chart.js due to practical considerations highlight the importance of adaptable project management strategies. Additionally, the project deepened my proficiency in PHP, JavaScript, SQL, and the effective use of version control with GitHub, enriching my technical skillset.

5.4 Lessons Learned and Personal Growth

The Sleep.io development path demonstrated how critical careful planning and efficient time management when developing a project of this scope. The project served as a reminder of how important it is to set reasonable timelines and deadlines, which is a fundamental technique for efficiently advancing projects. Furthermore, the ability to include flexibility into project milestones is evidence of the dynamic character of technical advancement, permitting a flexible response to unanticipated obstacles. This project served as a perfect example of how meticulous planning, when combined with iterative improvement, can accelerate the achievement of project goals.

Furthermore, the Sleep.io venture highlights the importance of an integrated approach to project management, which combines agile approaches with traditional methodologies to promote a flexible and resilient development process. With the use of this hybrid method, a framework that is both organised and flexible can be established, allowing one to adjust to the project's changing requirements while still following established deadlines and objectives. The insights gained from Sleep.io's experience clarify the complex issues related to software project management and emphasise the need of approaching planning, execution, and adaptation with careful consideration and strategy.

Sleep.io's development from idea to completion I feel is one of success, highlighted by the accomplishment of its key objectives. This only lays the groundwork for further development and improvement. The project brings to light several critical areas that are ready for more work, most notably the pursuit of increased personalisation, the improvement of user feedback methods and perhaps some more rigorous bug testing. However overall I feel that I can proudly present Sleep.io and come away from this project with many lessons learned and valuable experiences gained.

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APPENDIX A

A1. PHP Function Breakdown and coding logic

Profile Page Functions:

i) Sleep Streak Calculation: the ‘calculateSleepStreak()’ function operates through iterating over a consecutive number of sleep entries, computing a continuum of daily sleep records. The recognition of a sleep streak is done by analysing and comparing the date stamps found in the stored SQL database. These dates are further narrowed and analyse through matching user IDs to ensure that all dates are from the correct and same respected user. The algorithm identifies the uninterrupted sequences of sleep entries and from there established a sleep streak metric which can be returned to the user. This function will be used primarily within the user profile through display and additionally used to contribute to the user’s consistency score. Secondarily, this function will be used within the tracker page as a sub score to the ‘Sleep Quality Score’

ii) Sleep Quality Assessment: The ‘getSleepQualityAverage’ purpose is to display to the user what their average sleep quality is over all sleep entries. The sleep quality is displayed through ratings, categorical data ('Excellent', 'Good', 'Fair', 'Poor'). This function operates through transposing this data into a numerical equal ('Excellent'=4, 'Good'=3, etc). This numerical equal can then be used to calculate and find the average number overall, which, can then be again transposed back into an equivalent quality rating. This function is a unique feature to only the profile page,to show their user their unique quality rating.

iii) Sleep time average: Complementing the quality assessment is the ‘’getSleepTimeAverge’ function. This function works through analysing the mean sleep duration across recorded entries unique the user ID. The function then converts the time stamps in distinct parts-Hours, minutes, seconds-and then transmutes those parts into a singular unit of minutes. From here we can then calculate the sleep duration average in minutes by comparing all minute averaged entries, which can then be reconverted back into a time stamp to get the end user a sleep time average

Tracker Page Functions:

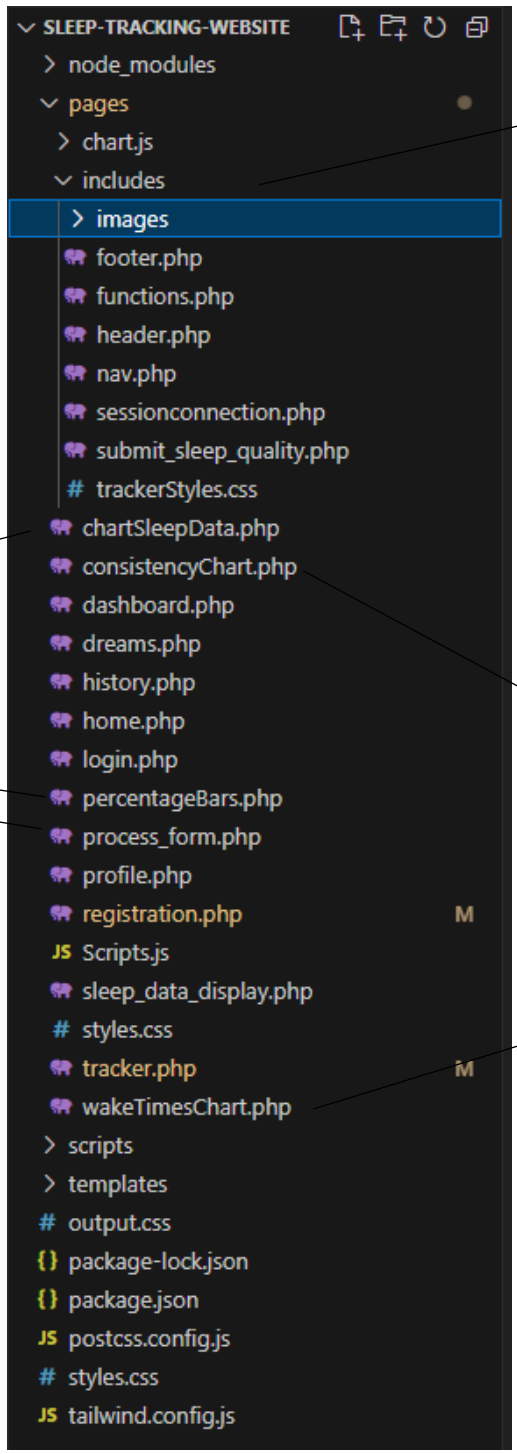
iv) Calculating Sleep Score: the ‘calculateSleepScore’ function is primary analysis tool of user-specific analysis. To begin, the most recent sleep data entry is queried, after which this data is then processed using an intensive scoring algorithm. The sleep quality categories are given values by the algorithm, which creates a range from ‘very bad' to 'Excellent’. From there these qualities are mapped onto a numerical score ranges through use of an array. The algorithm will then distinguish between different benchmarks for sleep durations which can then be used as a dynamic multiplier to alter the score of the user. This calculation was taken into consideration as the quality of sleep isn’t the only factor that truly affects your sleep health, sleep duration does also.

v) Wake Time Retrieval: The getLatestWakeTime() function along with the sleep duration retrieval function provides the end user with a complete picture of the users sleep cycle. In turn this provides other functions with the tools necessary to

full complete an analysis of the users sleep cycle, making this function a core element of the project.

vi) Average Bedtime: A key function for users when discussing the importance of one's sleep, is knowing there average bedtime. The function 'getAverageBedtime()' delivers a calculated average by iterating through all user data and then calculating the average which will then be returned to the user as a recommendation of tonight's sleep.

A2. File Structure of Project



Includes: I created this file for organisation. These are files that are likely to be used across multiple pages, such as the nav bar, database connection, header, footer,etc.

Files such are ChartSleepData.php, percentageBars.php, process_form.php are files that are purely functional and contain functions that are used throughout the system

These files contain charts that were created separately from the page they are presented on for maintainability purposes.

A3. Tailwind and Awesome fonts closer look

```
! —My Generic pseudocode for implementing FontAwesome icons onto a Home page -->

<link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/font-awesome/5.15.3/css/all.min.css"> //link to styles sheet

<a href="specific_page.php" class="icon-container flex flex-col justify-center items-center p-4 rounded-lg bg-gradient">

  <i class="fas fa-specific-icon fa-3x text-white mb-2"></i> //e.g. book Icon, Circle Icon, etc

   <p class="text-white text-lg">Page Description</p>
```

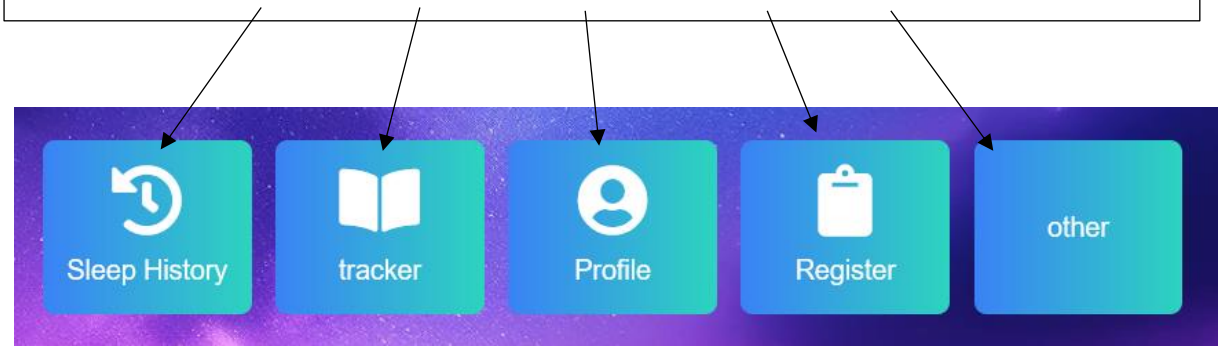


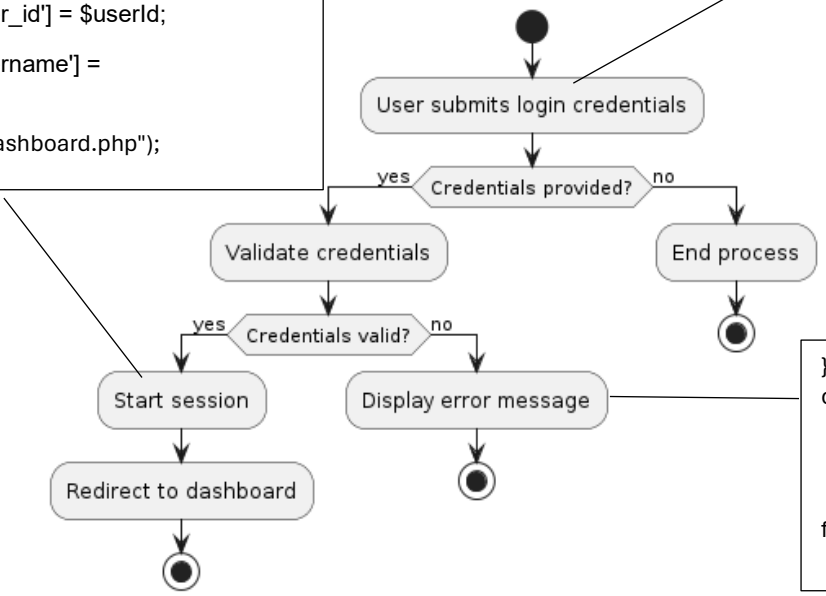
Figure 33 - Pseudo Code for use of visually striking imagery across the plat form, enhances website professionality.

```
//Actual code

<div class="flex-2 grid grid-cols-2 md:grid-cols-5 gap-4 p-8 text-center feature-fade-in">

  <!-- Icon 1 -->

  <a href="history.php" class="icon-container flex flex-col justify-center items-center p-4 rounded-lg bg-gradient-to-r from-blue-500 to-teal-400" href="#">

    <i class="fas fa-history fa-3x text-white mb-2"></i>

    <p class="text-white text-lg">Sleep History</p>

</a>

  <!-- Icon 2 -->

  <a href="tracker.php" class="icon-container flex flex-col justify-center items-center p-4 rounded-lg bg-gradient-to-r from-blue-500 to-teal-400">

    <i class="fas fa-book-open fa-3x text-white mb-2"></i>

    <p class="text-white text-lg">tracker</p>

</a>

  <!-- Icon 3 -->

  <a href="profile.php" class="icon-container flex flex-col justify-center items-center p-4 rounded-lg bg-gradient-to-r from-blue-500 to-teal-400" href="#">

    <i class="fas fa-user-circle fa-3x text-white mb-2"></i>

    <p class="text-white text-lg">Profile</p>

</a>

  <!-- Icon 4 -->

  <a href="registration.php" class="icon-container flex flex-col justify-center items-center p-4 rounded-lg bg-gradient-to-r from-blue-500 to-teal-400">

    <i class="fas fa-clipboard fa-3x text-white mb-2"></i>
```

A4. Session and Login Code management

```
if ($enteredPassword === $storedPassword) {
        session_start();
        $_SESSION['user_id'] = $userId;
        $_SESSION['username'] =
$enteredUsername;
    header("Location: dashboard.php");
```

```
if ($_SERVER["REQUEST_METHOD"] == "POST" && isset($_POST['login']))
```




```
} else {   $loginError = "Invalid
credentials. Please try again.";
        }
 } else {     $loginError = "User not
found."   }
```

Figure 34 - Simplified Login Flow Chart, with examples from login.php code.

A6. In-depth Look at 'calculateSleepScore()'

An In-depth look at the functioning of 'calculateSleepScore()'

Let's break down 'calculateSleepScore**()**' operation step-by-step, examining the logic and potential implications of each segment of the code.

1. Initialization and data retrieval

```
$sleepScore = 0;
$query = "SELECT * FROM sleep_tracker WHERE user_id = ? ORDER BY date_of_sleep DESC LIMIT 1";
$stmt = $conn->prepare($query);
$stmt->bind_param("i", $_SESSION['user_id']);
$stmt->execute();
$result = $stmt->get_result();
```

The function starts by initializing the sleep score to zero and preparing a SQL query to fetch the most recent sleep entry for the logged-in user. This approach ensures that the score calculation is consistently based on the latest data, making the analytics responsive and up to date.

2. Processing Retrieved Data

```
if ($result->num_rows > 0) {
   $row = $result->fetch_assoc();
```

Upon executing the query, the function checks for data availability. If the database returns a record, it proceeds by extracting this data for further processing. This ensures that the calculations are based on actual user inputs rather than default values.

3. Mapping Sleep Quality and Calculating Base Score

```
$qualityScoreMap = ["Excellent" => [90, 100], "Good" => [80, 89], ...];

$sleepQuality = $row['sleep_quality'];

$baseScoreRange = $qualityScoreMap[$sleepQuality];

$baseScore = ($baseScoreRange[0] + $baseScoreRange[1]) / 2;
```

Sleep quality is quantified by mapping descriptive labels to numerical ranges. The function retrieves the user's reported sleep quality and assigns a base score from the mapped range. This score serves as the starting point for further adjustments based on sleep duration.

4. Adjusting Score Based on Sleep Duration

```
list($hours, $minutes, $seconds) = explode(':', $row['sleep_duration']);

$hoursSlept = $hours + ($minutes / 60);
```

The function converts the sleep duration from a string format to total hours, which plays a critical role in adjusting the initial score. Understanding the duration of sleep allows the function to apply relevant multipliers, making the score more reflective of actual sleep quality.

5. **Applying Duration Multiplier**

```
$durationMultiplier = 'normal'; // Default

// Conditions to determine the appropriate multiplier

$sleepScore = $baseScore * $durationMultipliers[$durationMultiplier];
```

A default duration multiplier is set and adjusted according to how the user's sleep duration compares against established healthy thresholds. The base score is then modified by this multiplier, refining the sleep score to account for the quantity of sleep.

6.Bonus for Optimal Conditions

```
if (($sleepQuality === 'Excellent' || $sleepQuality === 'Good') && $durationMultiplier === 'optimal') {

   $sleepScore += 1;  // Bonus for optimal sleep conditions

}
```

An additional bonus is added if both the sleep quality is high and the duration falls within the optimal range, encouraging users to maintain good sleep habits.

7. Final Adjustments and Return

```
$sleepScore = max($baseScoreRange[0], min($sleepScore, $baseScoreRange[1]));

return round($sleepScore);
```

Before finalizing the score, the function ensures it falls within the acceptable range defined for each sleep quality category. The score is adjusted to stay within these bounds, then rounded off to produce a clean, user-friendly output that is returned as the final sleep score.

A7. Hypnogram Chart In-depth Look

Data Retrieval

The getLatestSleepData() function is crucial for ensuring the hypnogram displays the most up-to-date sleep data. By fetching the latest sleep entry for the user, this function lays the groundwork for all subsequent calculations and visualizations, providing the raw data necessary for accurate analysis.

```
function getLatestSleepData() {
    global $conn;
    $query = "SELECT sleep_time, wake_time, sleep_quality FROM sleep_tracker WHERE user_id = ? ORDER BY date_of_sleep DESC LIMIT 1";
    $stmt = $conn->prepare($query);
    $stmt->bind_param("i", $_SESSION['user_id']);
    $stmt->execute();
    $result = $stmt->get_result();
```

Sleep Stage Calculation

The calculateSleepStages() function is a sophisticated element of Sleep.io. It takes the start and end times of sleep as input and calculates the duration spent in each sleep stage. The breakdown of these stages includes:

N1 (Light Sleep): Transition phase into deeper sleep levels.

N2 (Intermediate Sleep): Typically the longest phase, where the body prepares for deep sleep

N3 (Deep Sleep): The most restorative phase, crucial for physical recovery and health.

REM (Rapid Eye Movement Sleep): Associated with dreaming and brain activity similar to wakefulness.

These stages are adjusted based on the reported sleep quality, affecting the time attributed to each stage. -

```
function calculateSleepStages($sleepTime, $wakeTime, $sleepQuality) {
    $sleepDuration = (new DateTime($sleepTime))->diff(new DateTime($wakeTime))->format('%h hours %i minutes');
    $qualityAdjustments = getQualityAdjustments($sleepQuality);

    // Assuming simplistic distribution for demonstration
    return [
        'N1' => $sleepDuration * $qualityAdjustments['N1'],
        'N2' => $sleepDuration * $qualityAdjustments['N2'],
        'N3' => $sleepDuration * $qualityAdjustments['N3'],
        'REM' => $sleepDuration * $qualityAdjustments['REM']
    ];
}
```

Percentage Calculation

Following the stage calculations, the calculateStagePercentages() function processes these durations into percentages. This conversion is essential for the graphical representation in the hypnogram, making the data not only more comprehensible but also visually accessible to the user.

Visualization with Chart.js

The visualization process involves dynamically creating a chart using Chart.js, configured to accurately display the sleep cycle stages over the course of the night. The script takes the processed sleep data, applies a transformation to align it with a time-based chart, and uses gradients to enhance visual clarity. Here's a more detailed look at the script's functionality:

```
<script>
const sleepData = <?php echo json_encode(getLatestSleepData()); ?>;
const sleepCycles = <?php echo
json_encode(calculateSleepStages(sleepData['sleep_time'],
sleepData['wake_time'], sleepData['sleep_quality'])); ?>;


// Transform sleep cycle data into Chart.js format
const transformedData = sleepCycles.map((stage, duration) => ({
    x: new Date('1970-01-01T' + sleepData['sleep_time'] + 'Z'),
    x2: new Date('1970-01-01T' + sleepData['wake_time'] + 'Z'),
    y: stage,
    duration: duration
}));
const ctx =
document.getElementById('sleepCycleChart').getContext('2d');
const chart = new Chart(ctx, {
    type: 'line',
    data: {
        datasets: [{
            label: 'Sleep Stage',
            data: transformedData,
            borderColor: 'rgba(75, 192, 192, 1)',
            backgroundColor: 'rgba(75, 192, 192, 0.2)',
            borderWidth: 2,
            pointRadius: 3,
            tension: 0.1
        }]
    },
    options: {
        scales: {
            x: {
                type: 'time',
… Continues
```

```
…Continued…
time: {
                    unit: 'hour',
                    displayFormats: {
                        hour: 'HH:mm'
                    }
                }
            },
            y: {
                type: 'category',
                labels: ['N1', 'N2', 'N3', 'REM']
            }
        }
    }
});
```

The **consistencyChart.php** file is integral to the operation of the sleep consistency chart. The PHP script collects and processes user sleep data to prepare for visualization. The process includes:

```
$userId = $_SESSION['user_id'] ?? exit('User is not logged in.');  // Ensures user is authenticated.

$query = "SELECT date_of_sleep, sleep_time FROM sleep_tracker WHERE user_id = ? ORDER BY date_of_sleep ASC";

$stmt = $conn->prepare($query);

$stmt->bind_param("i", $userId);

$stmt->execute();

$result = $stmt->get_result();
```

```
while ($row = $result->fetch_assoc()) {

  $timeParts = explode(':', $row['sleep_time']);

  $timeAsDecimal = $timeParts[0] + ($timeParts[1] / 60);

  $sleepData[] = [

    'date' => $row['date_of_sleep'],

    'sleepTime' => $timeAsDecimal  ];

}
```

```
$averageSleepTime = array_sum(array_column($sleepData, 'sleepTime')) / count($sleepData);
```

Figure 35 - Consistency Chart Code

1.Data retrieval

The initial step involves fetching the sleep data from our database. This process is crucial as it forms the foundation of the chart.

It orders the records in ascending order and retrieves that sleep times and dates stored for later use to plot on the graph

2.Data processing

Here, each sleep time is converted into a decimal format, making it suitable for graph representation. This conversion is critical for plotting in Chart.js, where numerical values along the y-axis represent sleep times. Adjusting times that span past midnight (**$timeAsDecimal**) ensures that the visualization accurately reflects the user's sleep cycle, enhancing the utility and accuracy of the chart.

3. Average Calculation

Here, this code computes the mean of all recorded sleep times, offering a quick snapshot of the user's typical bedtime. Displaying this average on the chart helps users visually assess their consistency relative to their average, promoting better sleep habits through self-awareness.

A9. Test cases

Requirement	Test Case ID	Description	Expected Result	Actual Result	Pass/Fail
User Registration	TC01	Register with valid details	User is successfully registered	User is successfully registered	Pass
	TC02	Register with missing details	Error message for	Error message displayed	fail

			incomplete details		
	TC03	Register with an already used email	Error message for email already in use	Error message displayed	fail
User Login	TC04	Login with valid details	User is successfully logged in	User is successfully logged in	Pass
	TC05	Login with invalid username	Error message for invalid username	Error message displayed	Pass
	TC06	Login with invalid password	Error message for invalid password	Error message displayed	Pass
Sleep and Wake Time Entry	TC07	Enter valid sleep and wake times	Data is successfully recorded	Data is successfully recorded	Pass
	TC08	Enter invalid times (e.g., future date)	Error message for invalid times	Error message displayed	fail
Sleep Quality Rating	TC09	Rate sleep quality with available options	Rating is accepted and recorded	Rating is recorded	Pass
	TC10	Leave sleep quality rating blank	Error message for missing rating	Error message displayed	Pass
Adding Comments	TC11	Add valid comment	Comment is saved	Comment is saved	Pass
	TC12	Add a comment with special characters	Comment is saved with sanitization	Comment is saved without special chars	Pass
Sleep Duration Calculation	TC14	Submit sleep and wake times	Sleep duration is calculated	Sleep duration is correctly calculated	Pass

Sleep Score Generation	TC15	Submit sleep data with good quality	High sleep score is generated	High sleep score is generated	Pass
	TC16	Submit sleep data with poor quality	Lower sleep score is generated	Lower sleep score is generated	Pass
Sleep Stage Visualization	TC17	View sleep data	Sleep stages are visualized in chart	Chart displays sleep stages	Pass
Historical Data Review	TC18	Access history page	Displays all past sleep data	Successfully displays historical data	Pass