GoodNight: Sleep Deprivation In College Students

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Project Brief

College students get irregular hours of sleep which can affect their short-term and long-term performance in classes and daily activities. This can be due to a variety of factors including but not limited to an overload of activities including classes, work, clubs, and maintaining a social life. However, we believe existing solutions do not sufficiently address college students' needs and ensure they get an acceptable amount of quality sleep per night depending on upcoming events (midterms, finals, or a 10 hour shift at work).

Team Members

Taylor Blackburn: I am a junior majoring in Biology and minoring in Informatics. I am proficient in coding in R and Python, and will be assisting in the development and data science portion of our final project. However, I am very flexible and can assist in other areas as needed.

Ben Cherry: I am a Junior in Electrical Engineering and I am interested in informatics. I have a strong technical background and will focus on designing any hardware we need, although I am flexible and will help with other aspects of the project as needed.

Sophia Hwang: I am a junior majoring in Electrical Engineering and minoring in Informatics. Although I come from a technical background, I have also worked in analytics and UX research which is where my main interests lie. I will be mainly focused as a User Researcher in this project, potentially with the Development side as well if needed.

Tracy Tai: I am a junior in UW, majoring in Psychology and interested in a minor in Informatics. I have an interest in drawing, and I will be in charge of designing the project. I am proficient in analyzing data using Excel and Jamovi, also proficient in coding in Java. I will be flexible in helping other areas if needed.

Jay Woo: I am a Sophomore intending to major in Informatics. In this project, I will focus on User Researcher as I research and collect data. However, I am flexible and will help in other areas if needed.

Problem Statement

Introduction

College students get irregular hours of sleep due to an overload of activities including classes, work, clubs, and maintaining a social life. Most college students have the option of using sleep tracking apps or devices, but these softwares are typically designed for a wide range of people. Lack of sleep has also been shown to result in lower productivity, starting a vicious cycle of choosing studying over sleep, resulting in lower quality of studying and thus more time needed to study. This in turn causes students to forgo even more sleep. This is a clear problem for college students, especially those who have jobs and extracurricular activities. We believe that a solution is necessary to specifically target college students and ensure they get an acceptable amount of quality sleep per night depending on upcoming events (midterms, finals, or a 10 hour shift at work). This will help to alleviate the fact that college students get less sleep than the average person.

User Research

Surveys

We conducted a survey to collect information on college student's sleeping habits and quality of sleep, as well as gather information on the use of devices and apps meant to track sleep and sleeping habits. With this direct survey approach, we are able to easily gain information directly from the sources that know students' sleeping habits the best: themselves. The survey was sent out to associates of the researchers and was posted in a Discord Server for Info 200 students. General demographics such as year in college and current time zone were collected, as they were deemed important to understanding the influences these demographics have on sleep. Data on the alcohol, drugs, and caffeine use among respondents was also collected.

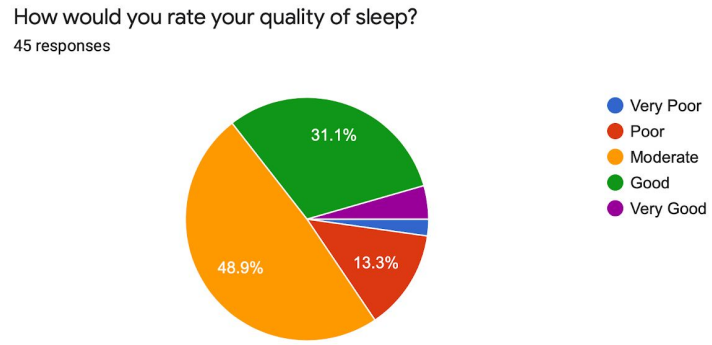
Some key questions that were asked include: "How would you rate your quality of sleep?", "Have you ever used sleep tracking apps or devices?" and "Describe your

sleep schedule (Include naps and All-Nighters)". The first question was asked using a standard 5-point Likert Scale, the second question was yes or no, and the third question was a short response. These questions were asked to gauge people's opinions on the effectiveness of existing solutions. The survey questions can be found at https://forms.gle/Qpf9y2t4MijWtjmd6, and the results can be found at https://docs.google.com/spreadsheets/d/1aSPwIcfkWu7MHLiYZ5ZIzAO5xqqaij0_KDW_CrHrMRQ/edit?usp=sharing.

In total, we received 45 responses from our survey. They were all University of Washington college students and ranged from freshmen to seniors. Most respondents were located in Pacific time, although there were about 15% surveyed who live in different time zones.

Some key insights include:

- Most respondents slept between a time frame of 12-4am and woke up between 8-10am, with a few respondents taking naps throughout the day
- Typical habits before sleeping include less rigorous activities and usage of electronics such as scrolling through smartphones, gaming, etc.
- When respondents don't get enough sleep, they note decreased performance in productivity and experience less motivation to attend classes and complete schoolwork
- About half were interested in using a sleeping tracker but some said that they want more than just showing the graphs or results in order to improve their sleeping habits. Many expressed concerns that sleep trackers were too inaccurate and not proactive enough to be effective and change their sleeping habits for the better.
- About half of respondents were not satisfied with their sleeping habits and hope to shift their sleeping time earlier.
- Multiple respondents wanted to rely less on alcohol and recreational drugs to sleep/maintain a stable schedule



Interviews

Stakeholder Interview

The stakeholder interview we conducted was with a college student living in an apartment complex near the University of Washington campus. Our goal was to further understand college students' typical sleeping habits and their needs in maintaining a sufficient sleep schedule. We used this research method because we were able to ask more open-ended questions and gather more detailed information than we could've from the survey. We felt the participant was also more willing to divulge more about her sleeping habits in a conversational setting as opposed to online methods.

Key Questions asked in the interview:

1. Tell me about your current sleeping habits
2. How have your sleeping habits changed over the course of your undergraduate career?

3. How do your sleeping habits affect your performance in school?
4. How do you feel about sleep tracking apps and/or devices?

These questions were used because we wanted to understand what factors may be causing their poor sleeping habits, as well as their desire in managing these habits in relation to their academic studies.

Some key Insights we gathered from the interview:

- Consistently sleeps late every day (past 3am) and usually doesn't struggle to fall asleep but has a hard time waking up in the mornings
- Sleeps more than she did in high school (7 hours avg compared to 5-6 hours in high school) but still feels equally as tired
- Not satisfied with her sleeping schedule - however, there currently isn't anything that is externally motivating her to change and she recognizes she is bad at holding herself accountable
- Wishes she could be more productive during the day, but she is tired all the time and has noticed when she isn't very alert she is slower at understanding and keeping up with class content

User Interview 2

The second user interview was a college student in her junior year living in a house with eight other housemates that has been diagnosed with insomnia for 5 years. The purpose of this interview was to gain a different perspective from the same group of direct stakeholders (college students). However, this person has a diagnosed sleep disorder in addition to the difficulty of obtaining a normal sleep schedule due to factors experienced by college students. This research method was appropriate in order to gain a complete overview of a college student that experiences factors like insomnia that worsens their ability to get a normal amount of sleep than the average college student.

Key Questions asked in the interview:

1. Tell me about your current bedtime routine.
2. How much sleep do you average a night?
3. Why do you think that your sleep is so poor?
4. How do you feel about sleep tracking apps and/or devices?

5. How do your sleeping habits affect your performance in school?

Key insights gained from interview:

- Typical bedtime routine: Watch a show and turn it off around 3, play sudoku for about 2 hours
- Sometimes she can fall asleep after that routine
- Sometimes she can' fall asleep as what she believes due to anxiety and built up energy since she is around 8 other housemates all day and the only alone time is before bed- so she is unable to turn her mind off
- Typically goes to bed around 4 AM and averages 5 or 6 hours of sleep a night
- Has used sleep tracking apps in the past (Sleep Cycle)
- Did not work- but enjoyed tracking sleep patterns
- Does not believe that current sleeping habits affect performance in school- has become so consistent that it has become the new norm

User Interview 3

The third interview we conducted was with a University of Washington student who is currently in China studying remotely. Due to the current Covid-19 situation, people who are studying in different time-zones are definitely encountering some problems with their sleep. Therefore, we interviewed an international student to get their experience in this situation for the purpose of understanding the current needs of students studying remotely. This research method was appropriate because there are a large number of students who are currently studying abroad, many of them have different time-zones within the Seattle area. Under different time-zones, sleep would be more difficult to adjust, as having classes at 5 in the morning. Therefore, it should be a chance for us to get to know more about this problem and think of possible solutions.

Key Questions asked in the interview:

1. How much sleep do you usually get per night?
2. Can you tell me about the differences with your current sleeping schedule and your sleeping schedule in 2019?
3. Could you please elaborate on your sleeping schedule? What did you do to moderate this situation?
4. How do you feel about sleep tracking apps and/or devices? Have you used them before?

5. If yes, what do you think should be improved in the device you have used?

Some key Insights we gathered from the interview:

- Though many professors have decided to modify their classes with no in-class participation, there are still classes that require in-class activities. He still has to go to his 1:30 PM classes which is 5:30AM in China. It is very tiring for him because he has to find appropriate time to email professors and classmates who are in Seattle, and his sleeping schedule is very different with his sleep schedule when he was in Seattle, he usually go to bed at 2 or 3 AM in the morning before, and now he has to go to bed around 7 or 8 AM. He can have enough sleep during day time, however, he still feels tired.
- He has used one sleep tracking app when he was in high school, and it didn't work very well because it lacked sleep patterns. He thinks if a sleep tracker is useful, it should include more personalized information, like sleep patterns, to generate the best sleeping time during the day considering an individual's schedule.

User Personas

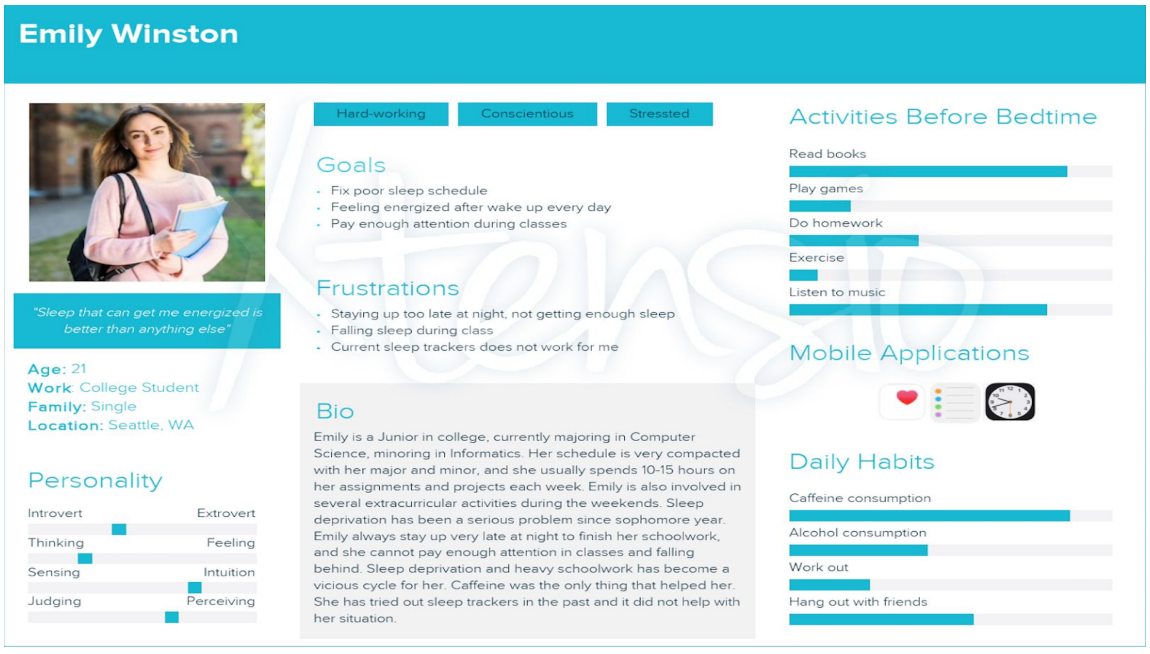


Fig. 1: User Persona 1

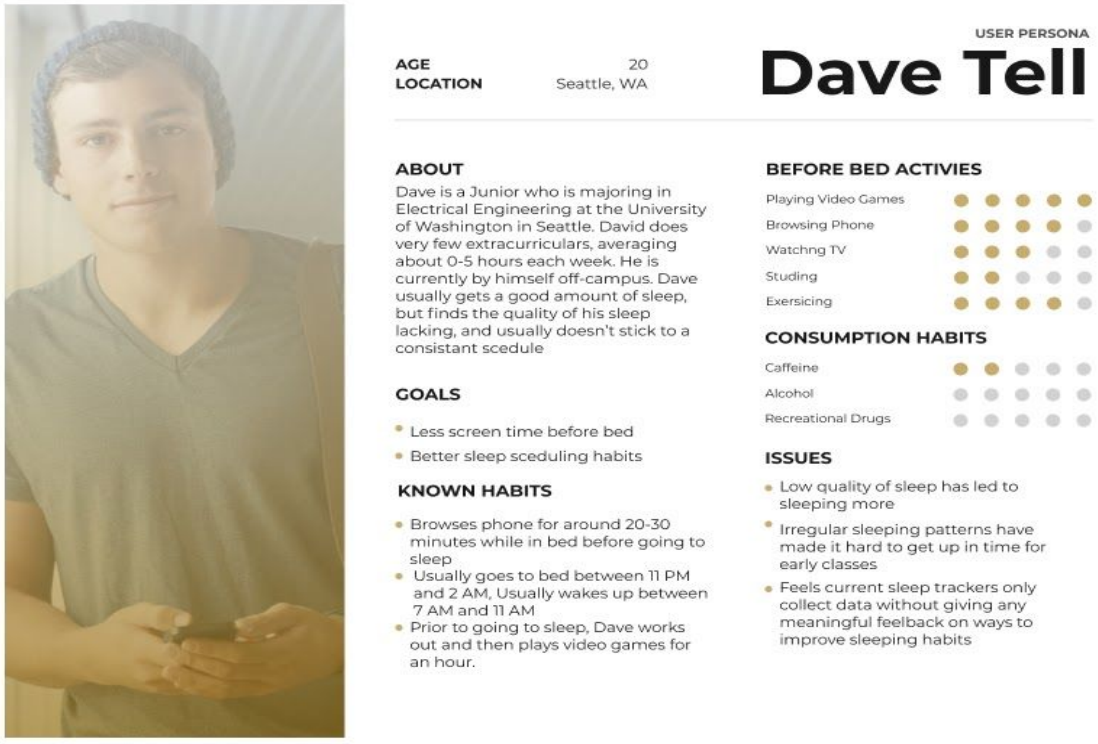


Fig. 2 User Persona 2

Solutions Considered

Solution 1: Wristwatch Tracker

The first solution we discussed was a wristwatch tracker. The sleep tracker could detect the user's sleep length and sleep quality to generate a moderate sleep schedule for each individual. The first week after a user starts using this wristwatch is the observation period, for the wristwatch tracker to collect enough personalized data from each individual's sleeping schedule, to generate the most moderate plan for its user. After the observation period, the system will generate a sleep schedule created for its user, and users can also modify it for individual preferences. When it is time to sleep, the tracker will vibrate twice. The wristwatch is constructed with a tiny screen showing time. If the user is not sleeping according to schedule, the time will change color to red, in a manner that will not interfere with normal personal behavior. There is also a button for playing music suitable for sleeping, and users can set playing time for 10 minutes to 1 hour. This device is created for people who have sleep deprivation or people whose sleep schedule have had negative effects in their life to improve their sleep schedule. However, the physical wristwatch may not be affordable to everyone, and a wristwatch may not be something that people like to wear everyday.

Solution 2: Immersive VR Experience

The second solution we considered was an immersive VR experience. With a headset, it provides a prime spot for EEG sensors to be attached so it can monitor your brain waves much more accurately than a standard phone application. It will then provide you with an immersive experience to instill a calm environment and help you sleep without distractions, which can be helpful for those with certain sleep disorders or students who have roommates who are still up. The advantages of this solution is that it addresses users' concerns with accuracy in measuring their sleep and can benefit those who have trouble falling asleep. However, there are two main disadvantages: the ergonomics of wearing a VR headset to bed can be very uncomfortable, and not everyone would realistically be able to afford such a device especially since our main users are college students.

Solution 3: Mobile Application

The third solution we considered was a sleep tracker mobile application. With the mobile app, people can track their sleep times and quality of sleep each night. People can also use the app to set up their schedules and get personal reminders on when they should start to prepare to sleep. Furthermore, when people are having trouble on sleep (sleep deprivation), they can directly ask and discuss with the professionals through this app. Since a smartphone is one of the factors that interferes with the sleep pattern nowadays, another positive feature of this app is to block the specific apps at specific time to not interrupt the sleep pattern. This approach is cheap in price for people who really have struggles to fall asleep and get treatment for sleep disorders. However, a negative feature is users' privacy issue since users have to enter their information.

Solution 4: Journaling Experience

Lastly, we considered a personalized sleep log journal for college students as a solution. By particularly targeting the habits of college students, we could format a specific template including sleep recommendations for users. This approach allows college students to take proactive steps in understanding their sleeping pattern and how they can personally improve it. However, we lose valuable information about sleep that users would be unable to recollect, like data over quality of sleep (what sleep stage the user was in at a specific time), heart rate, snoring patterns, and more. Furthermore, some users might be dissuaded from using this method as it requires significantly more time to use compared to other solutions. Time is critical for our target demographic because college students typically don't want to pursue an extra activity that will consume more time in their already busy schedule.

	Solution 1	Solution 2	Solution 3	Solution 4
Description	The physical sleep tracker could detect the user's sleep length and sleep quality to generate a moderate sleep schedule for each individual.	An immersive VR experience to accurately track sleeping habits and provide a calming environment to help users get quality sleep.	The mobile app that tracks the time and quality of a user's sleep. Can set up schdeules and discuss with professionals for those who have sleep deprivation.	A personalized journal template includes manual entry of hours slept, activities logged for the day, and other notes as needed.
Advantages	Automatic data collection, no need for manually enter data	EEG sensors can provide detailed REM sleep data, could be helpful for those with insomnia/related sleep disorders	Cheap, anyone who has smartphone can use it, user can set up the profile, can discuss with professionals	Proactive approach, users have to take responsibility in understanding sleeping habits.
Disadvantages	Buttons on wristwatch are not user friendly, wristwatch may be costly,	Extremely expensive, too narrow of a focus, bad ergonomics when using VR for sleeping	Uncertainty on privacy problem	Journal requires more time to complete, can't measure unconscious sleeping habits.

Selected Solution

We decided to combine Solution 3 with elements of Solution 1 to create a mobile solution that can be linked to a wristband tracker. The most important reasons to combine the two solutions is user-friendly application, direct data collection, and low-cost. Based on user research, students also spend a lot of time on their phone especially near bedtime, so having a mobile application would be very accessible to them. An mobile app would also be very easy to use for generating personalized preferences and set mobile notifications for sleeping time. Wristwatch is used for direct data collection, it can automatically detect sleep patterns for each individual and use the data to create the best possible solution for each person. It can avoid the time spent on manually entering data and protect data accuracy. College students are our main demographic, so we want to keep the solution as low cost as possible and not require expensive hardware. Wristwatch can function only as a data collector and timer, to minimize the cost needed. Compared to solution 2 and 4, mobile applications with wristwatches would be less costly and more personalized. For college students with unique course schedules and assignment due dates, a personalized plan is needed for every individual to improve their sleep quality. Our main solution will be focused on the mobile application, as we would design the application to function with or without the wristband tracker since not every student has access to a smart watch.

Description of Solution

Our solution consists of a smartphone app that will connect via bluetooth to a wristband sleep tracker. This app will keep track of the time and quality of sleep a person gets each night, as well as their pre-bed habits that can affect sleep such as Alcohol or Caffeine. The app will also allow the user to import their calendar and designate important events, and remind the user to get a good night's sleep before their important events. The app will provide recommendations to the user based on what was provided to generate tips for getting a better night's sleep, as well as show the user the data that was collected from their wristband. The app will also provide the ability to share the data collected with a sleep expert, who can provide more personalized feedback to the user.

Product Features

Primary Features

Feature 1: Personalized Goals and Recommendations

One of the primary features in our product is the ability to get personalized recommendations according to your sleeping habits. Our research shows users weren't satisfied simply by viewing their sleeping habits, as they still couldn't bring about actual change. In addition, finding the motivation to change their current habits was difficult. This feature aims to alleviate some of the user's responsibility to set effective goals by creating them already for the user, allowing them to take action based on a personalized plan tailored to their own lifestyle.

Since this sleep tracker is specifically targeting college students, there will be an option to input your daily schedule for the quarter/semester or import another calendar. In addition, you will set a few general goals such as sleeping earlier, sleeping more, etc. Based on these goals and activities, the application will generate an optimized sleep schedule and path to achieve that goal. For example, if your goal is to sleep earlier by 1 hour, the application will generate a recommended sleep schedule which shifts your sleep schedule by 15 minutes until you are gradually sleeping at your goal time, which you can also adjust. It will also give you recommendations if you are having trouble adhering to your current goals (e.g. tried to go to bed earlier but couldn't fall asleep or was on phone).

Feature 2: Access to Sleep Professionals for Personalized Advice

Based on our research, most users were dissuaded from using sleep tracking mediums that only displayed the length and quality of their sleep each night. In order to resolve that concern, our product will offer a service that connects users to sleep professionals/experts in order to get more tailored advice based on sleeping conditions that the app evaluates. There will be access to a 24/7 chat line that users can contact for recommendations on improving their sleep habits. A sleep specialist known as a somnologist can aid users with sleep apnea, insomnia, restless leg syndrome, narcolepsy, circadian rhythm disorders, and other sleep disorders

(American Sleep Association). There also will be therapists available to resolve conflicts regarding user's late-night anxiety or insomnia. The chatline will incorporate the secondary feature of logging daily activities to determine the cause of sleeping habits.

Sleep professionals (with user consent) will be able to access the user's caffeine consumption, alcohol/ drug use, screen time data, and other notes the user may choose to input. This allows professionals to have a holistic understanding of the user's sleeping habits and better advise the user on improving their sleep.

Secondary Features

Feature Name: Pop Up Reminders

A common feature that is seen on many mobile applications but which we wanted to emphasize in ours is the ability to receive pop up reminders. Many users expressed their desire to sleep earlier - as users are commonly on their phone before sleeping, it would be helpful to have reminders to let them know if they have an important exam or event the following day to urge them to put down their phone and sleep.

Feature Name: Log Daily Activities

Another feature of our app will include the option to log sleep-related activities (caffeine consumption, alcohol and drug use, screen time) to help aid the app in determining the user's likelihood of the quality of their sleeping habits. This data will also allow the app to generate personalized tips for how the user can improve their sleep. For example, if a user consumes 5 cups of coffee a day to counteract a night of little sleep, the app will suggest the user to drink one less cup of coffee and sleep 30 minutes earlier than their desired bedtime. The logged activities will improve the app's recommendations and data for helping the user achieve their desired sleep goals.

Feature Name: "Lockdown" Mode

Our research concluded that some users were unable to put down their devices at bedtime leading to a recurring cycle of poor sleeping habits. Our product will give users the option to "lockdown" their phone at varying degrees. This feature allows users to choose specific (or all) apps to lockdown at a specific time of their preference. For example, if a user spends all night on Netflix and Youtube, they can choose to disable only those two apps one hour before their desired bedtime. By assigning selective permission to their device, the user can activate or deactivate the "lockdown" at any point that they may choose.

SiteMap

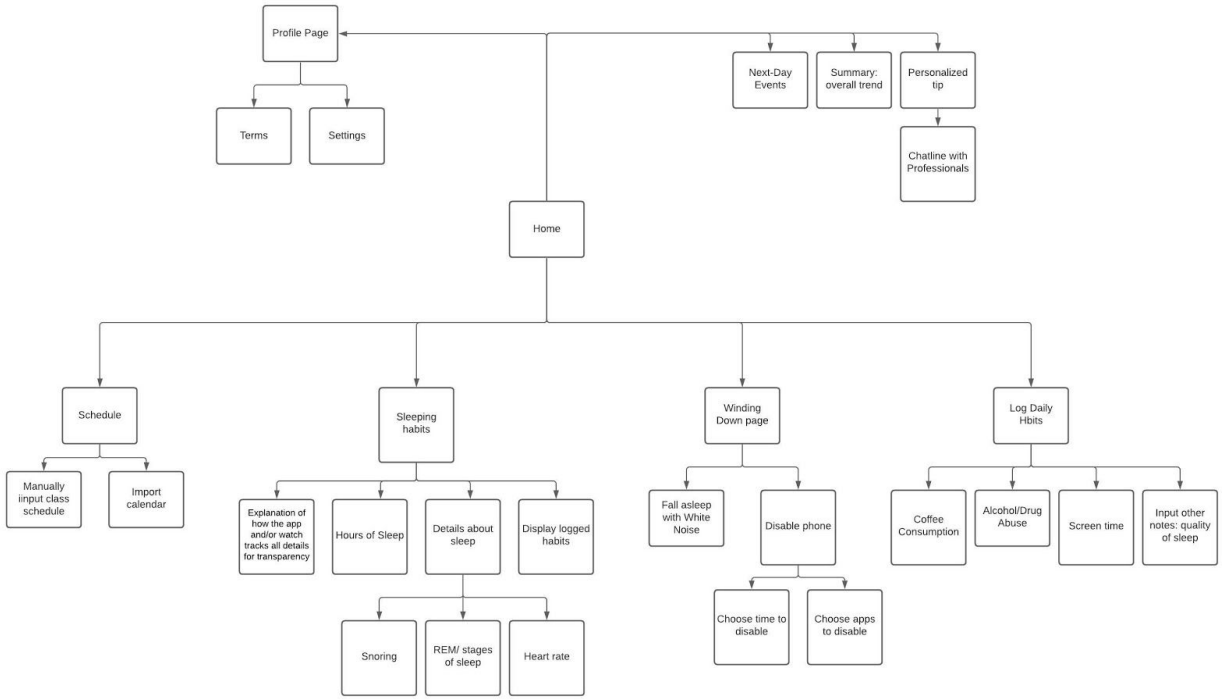


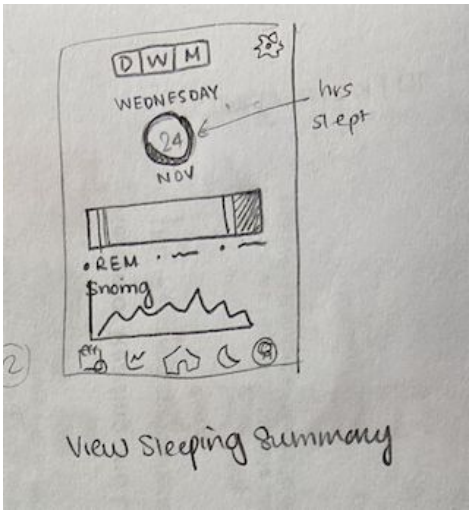
Fig. 3: SiteMap for mobile application solution

Low Fidelity Wireframes

Brainstorming Stage

In our brainstorming sessions, we first determined what wireframes we wanted to draw based on the SiteMap we constructed. We then drew out some of our individual ideas as to what the application might look like, with an emphasis on showcasing the primary features of the sleep tracking app - personalized sleep schedule and recommendations, and talking with sleep professionals. Finally, we converged ideas and discussed what parts of each other's designs we liked and wanted to include in our final wireframes.

Homepage



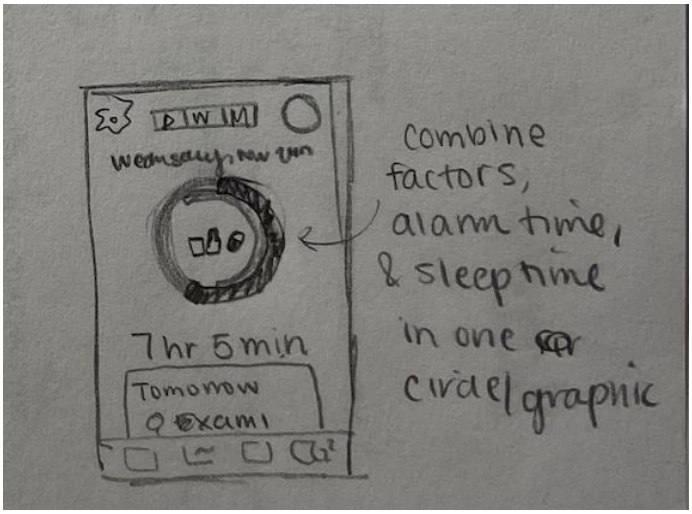
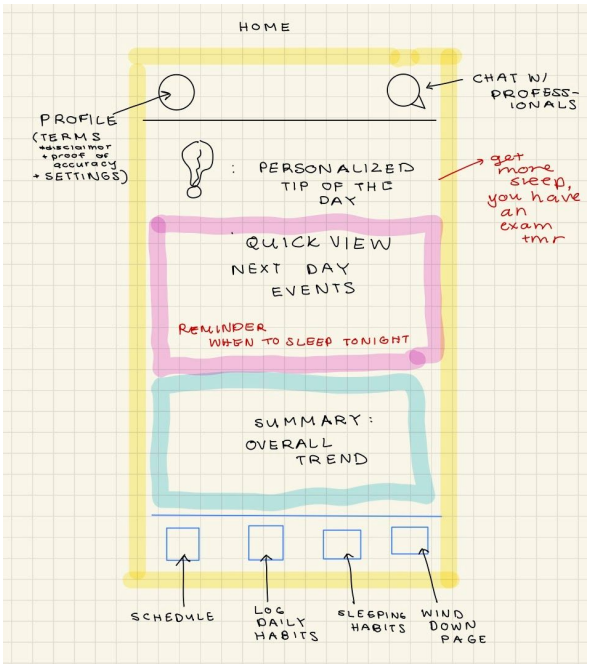


Fig. 4 and 5: First and Second iteration of Homepage



We experimented with different placements and features. The following are several iterations - the two pictures at the top were inspired by existing sleep trackers, where the homepage mostly consists of last night's sleeping habits for the user to easily view. However, we felt this did not emphasize the primary features of our app enough, and wanted to make the personalized recommendations and sleeping schedule more prominent. This led to the third picture which put personalized sleep recommendations on the front page and sleep quality simply on another tab.

Fig. 6: Third iteration of Homepage with personalized recommendations as focus

After comparing the before and after, we decided that users should be able to still easily view some details of their sleep without having to search for it every time, therefore we combined the design of the second and third picture so the top of the homepage would include the following design:

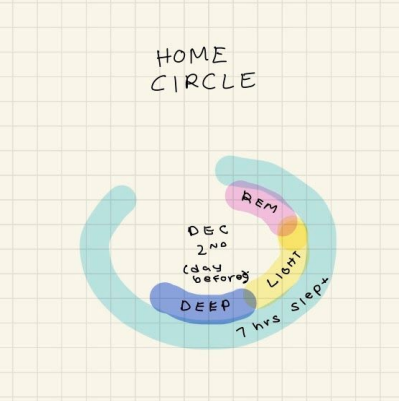


Fig. 7: Iteration for design of homepage center icon to display overview of sleep quality

Concentric circles are designed to show hours slept and different stages of sleep (assuming tracked), with the amount of circle filled being the percentage of last night's goal sleep that the user met. This way, the user can still receive an overview of their sleep but there is still an emphasis on their daily habits and personalized tips.

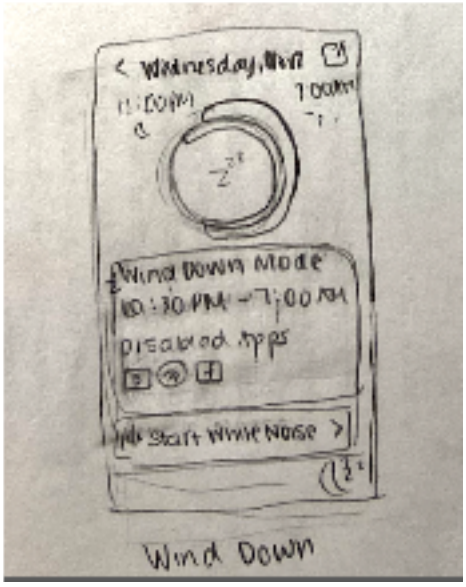
Below are more images of our brainstorms with annotations we discussed and added on our drawings. While discussing, we noted some important details we wanted to include in our final prototype which are also noted.

Talk with an Expert

We noted that we needed to provide a wireframe for the user to chat with professional experts on a 24/7 chat line. While we were not able to provide a picture for the brainstorm, we drew and discussed the necessary components for the chat feature: the user should be able to feel like they can trust the expert with their information. Therefore, we wanted to include a description of the sleep expert at the beginning of the conversation to instill trust right from the beginning of the conversation.

Wind Down

- Necessary features for user - alarm, white noise, disabled apps
- Visual representation for alarm would be better



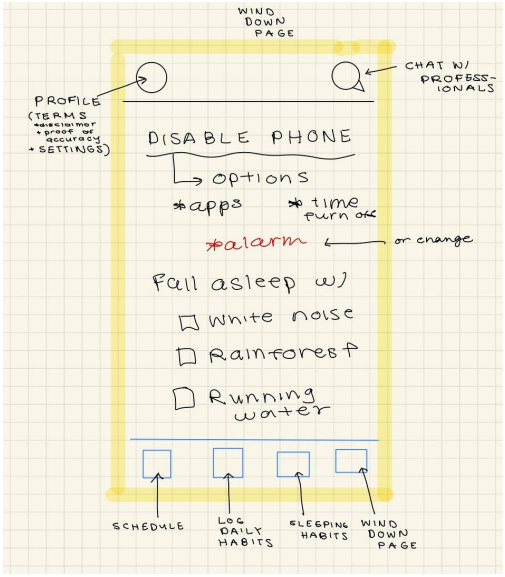
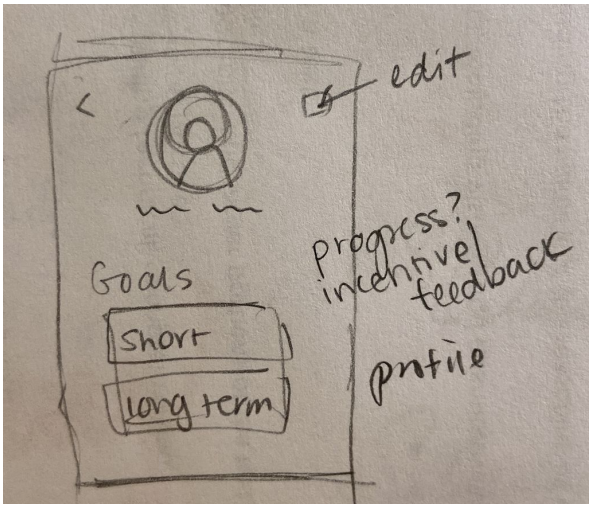


Fig. 8 and 9: Brainstormed ideas for mobile application Wind Down page

Daily Log and Goals

- Custom input for caffeine and alcohol intake instead of providing options
- Option to provide additional details and make them visible to sleep experts, or simply keep them for personal records (must put disclaimer)
- Provide some feedback or incentive for users to continue working on goals



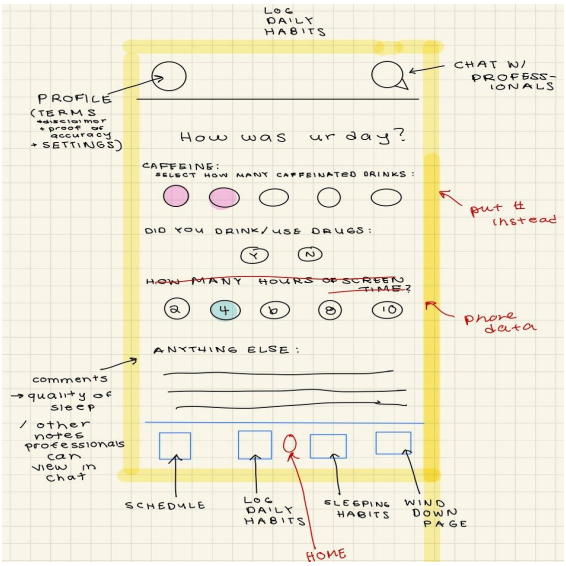
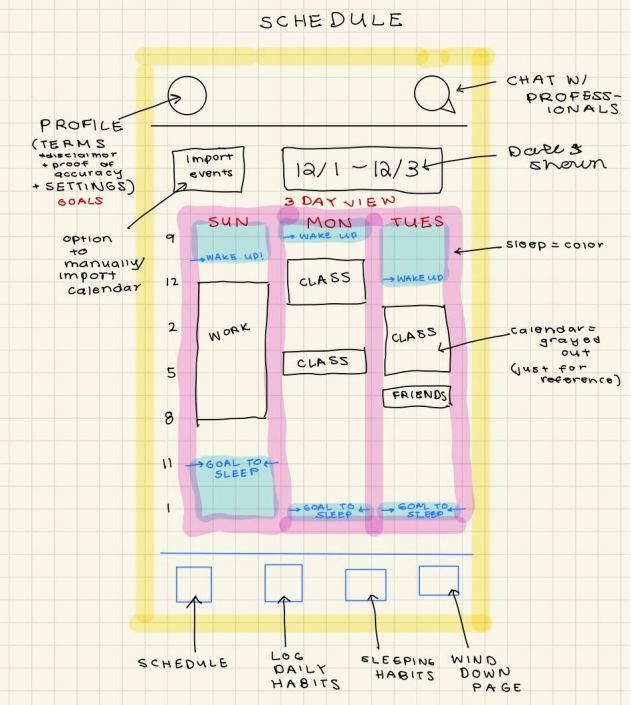


Fig. 10: Sketch of User Goals and potential signifiers

Fig. 11: Ideation for Daily Log tab

Schedule

- Avoid putting much detail - should be focused on the sleep schedule, not necessarily every activity put into the calendar
- Provide user with ability to edit or import an entirely new calendar
- Allow user flexibility to view sleep schedule in advance



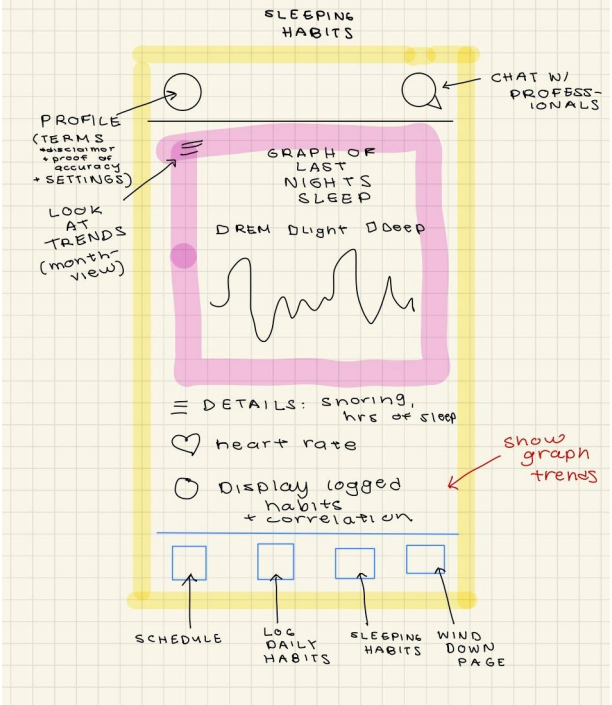


Fig. 12: Brainstorm sketch of sleep scheduler

Fig. 13: Brainstorm sketch of sleeping habits tab

Sleeping Habits

- Provide detailed explanation of sleep quality and other metrics tracked by phone and/or wristwatch
- Users should be able to view their logged daily habits to draw conclusions and correlations between sleep quality and their lifestyle

Final Low-Fidelity Wireframes

Screen 1: Homepage

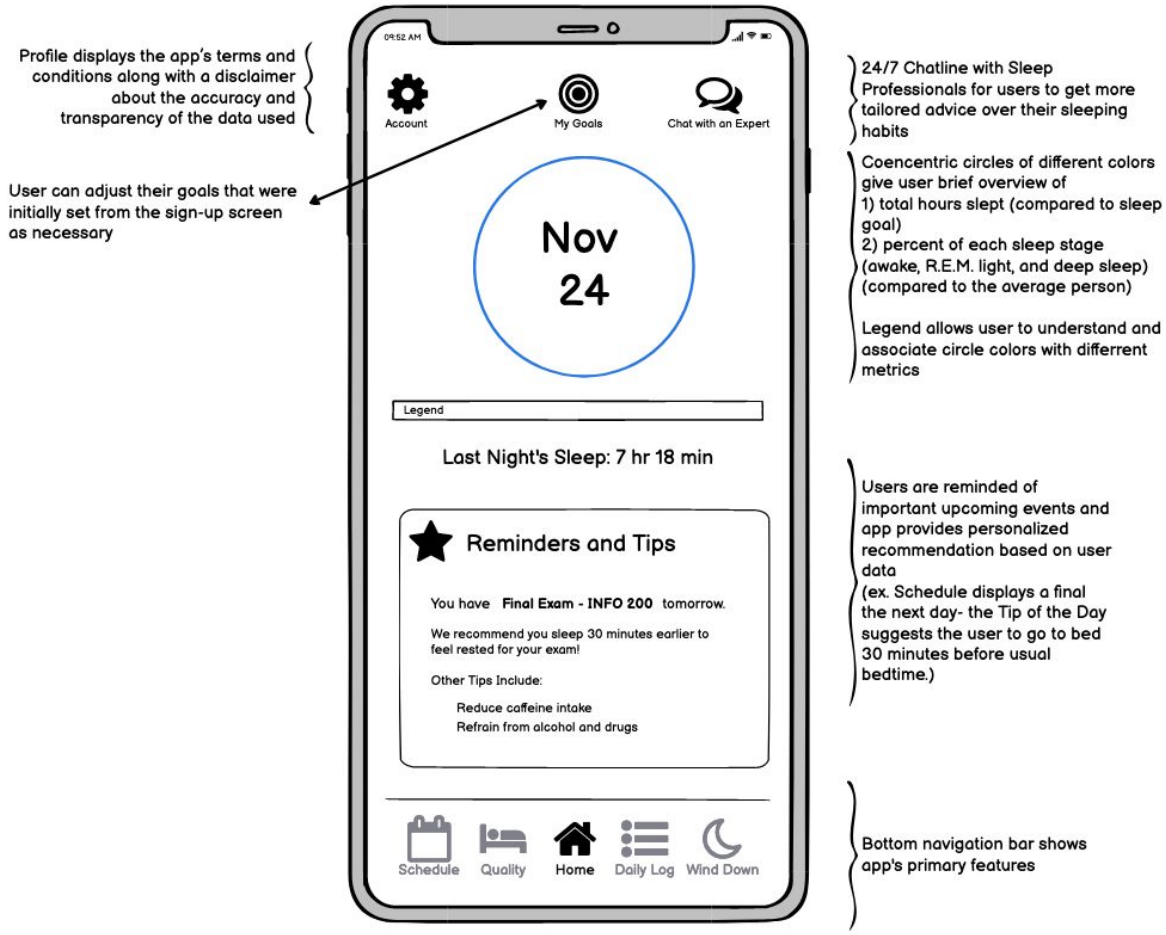


Fig. 14: Final low fidelity wireframe for Homepage

Screen 2: My Goals

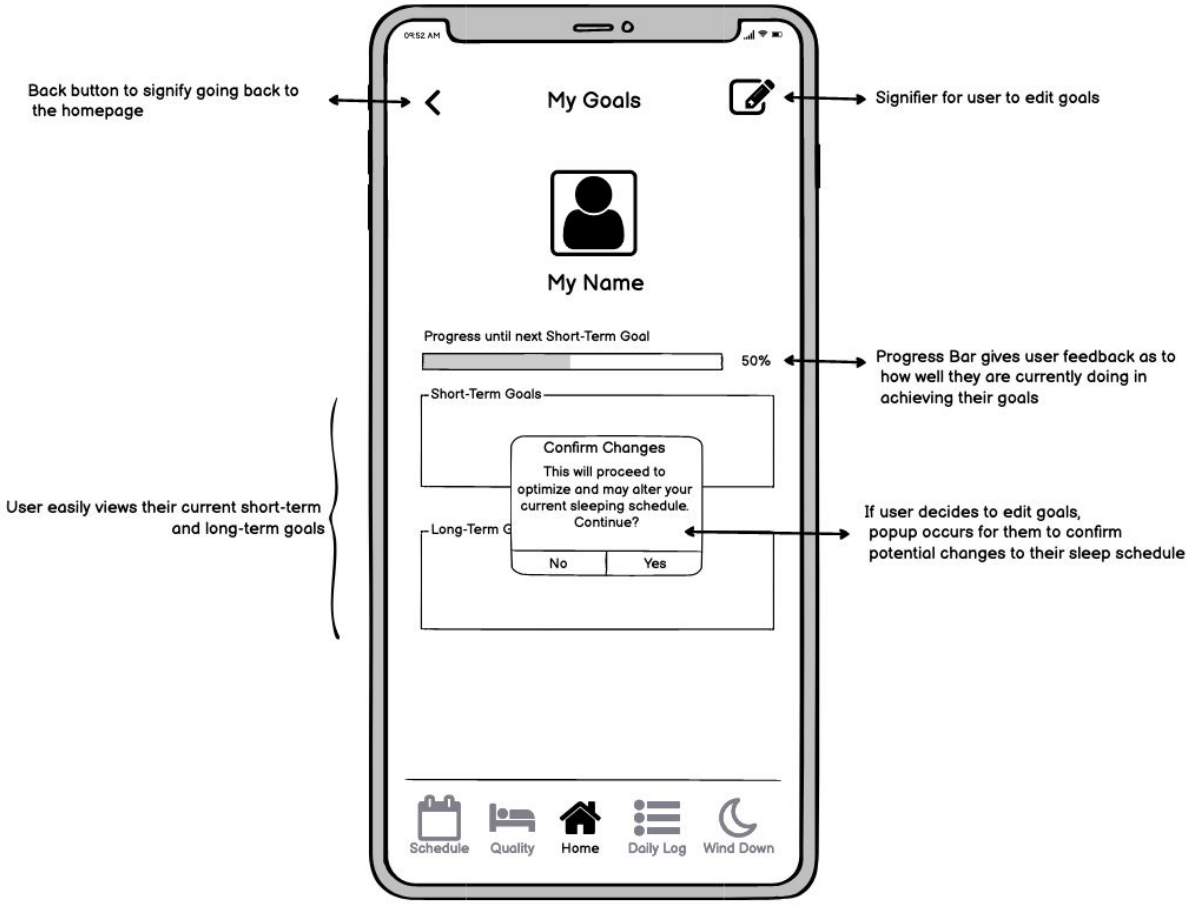


Fig. 15: Final low fidelity wireframe for My Goals

Screen 3: Talk with an Expert

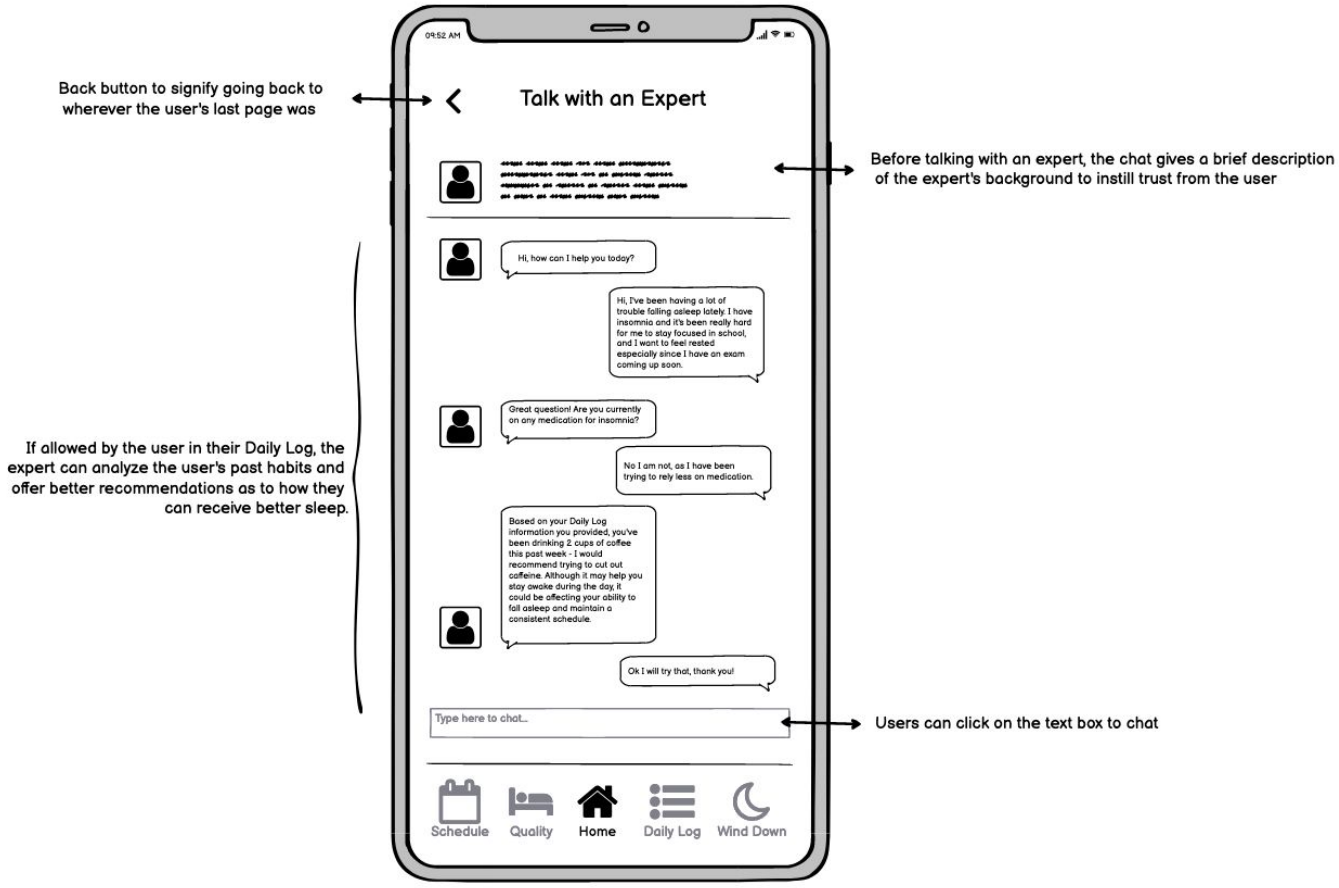


Fig. 16: Final low fidelity wireframe for talking with an expert

Screen 4: Sleep Schedule

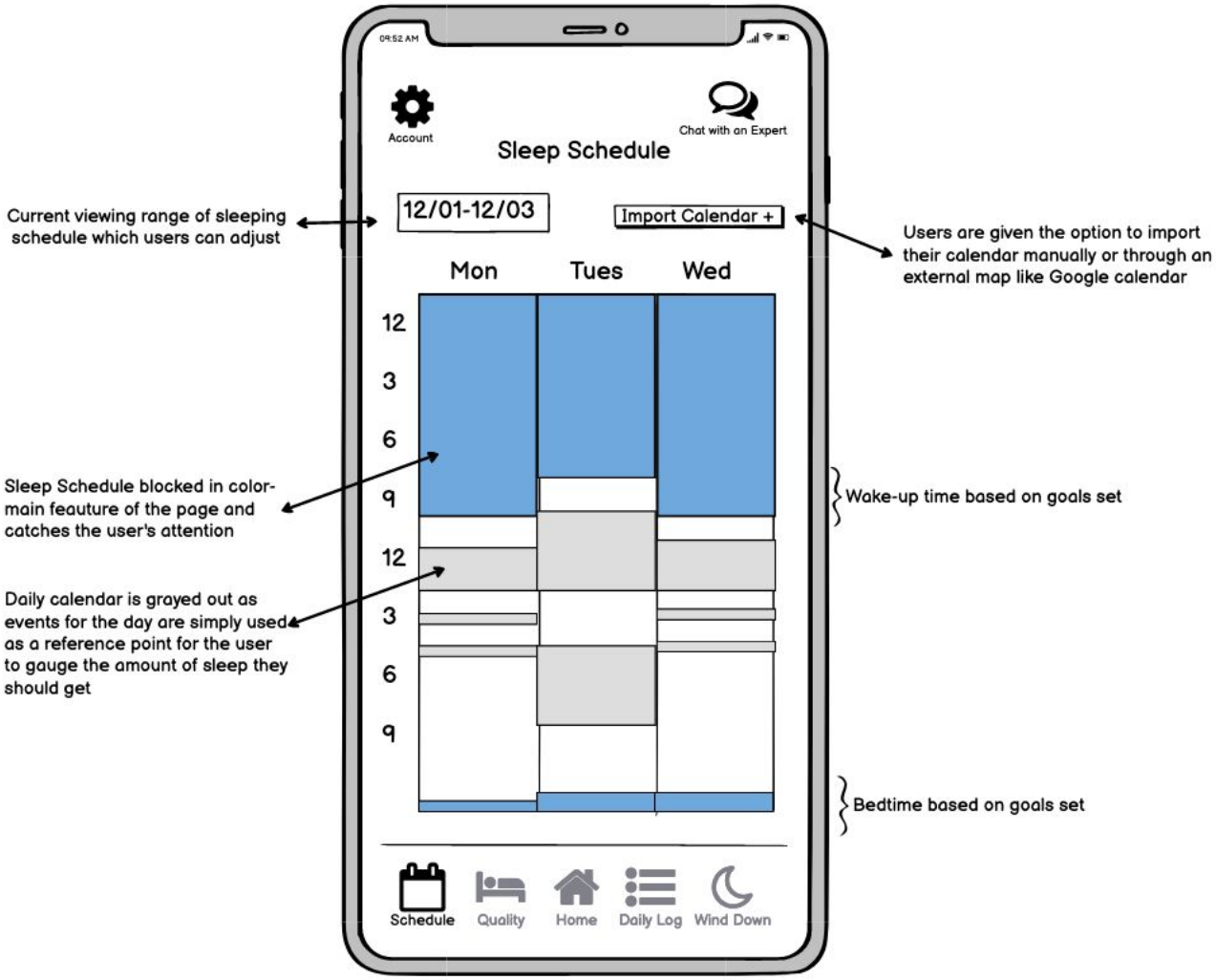


Fig. 17: Final low fidelity wireframe for viewing and editing the user's sleep schedule

Screen 5: Daily Log

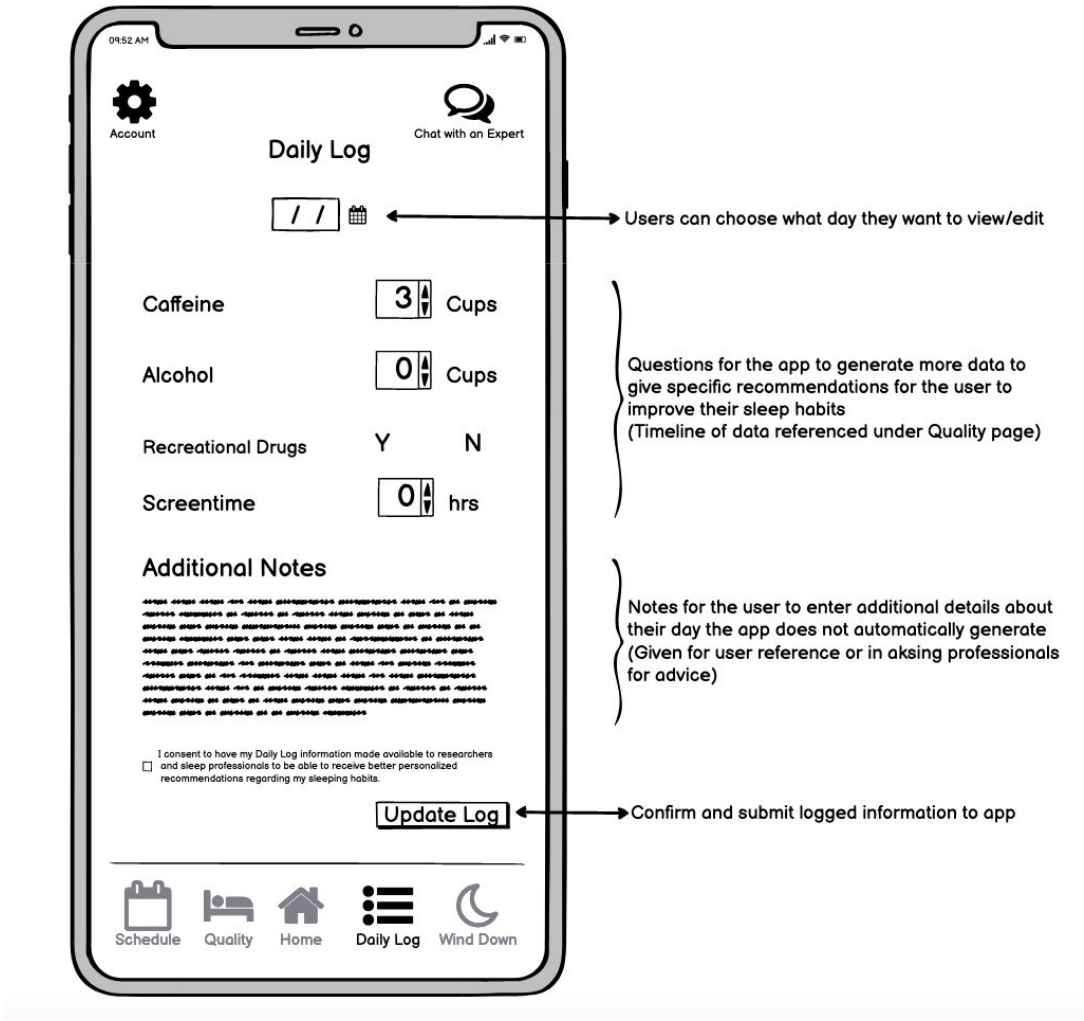


Fig. 18: Final low fidelity wireframe for the user logging in their daily habits

Screen 6: Wind Down

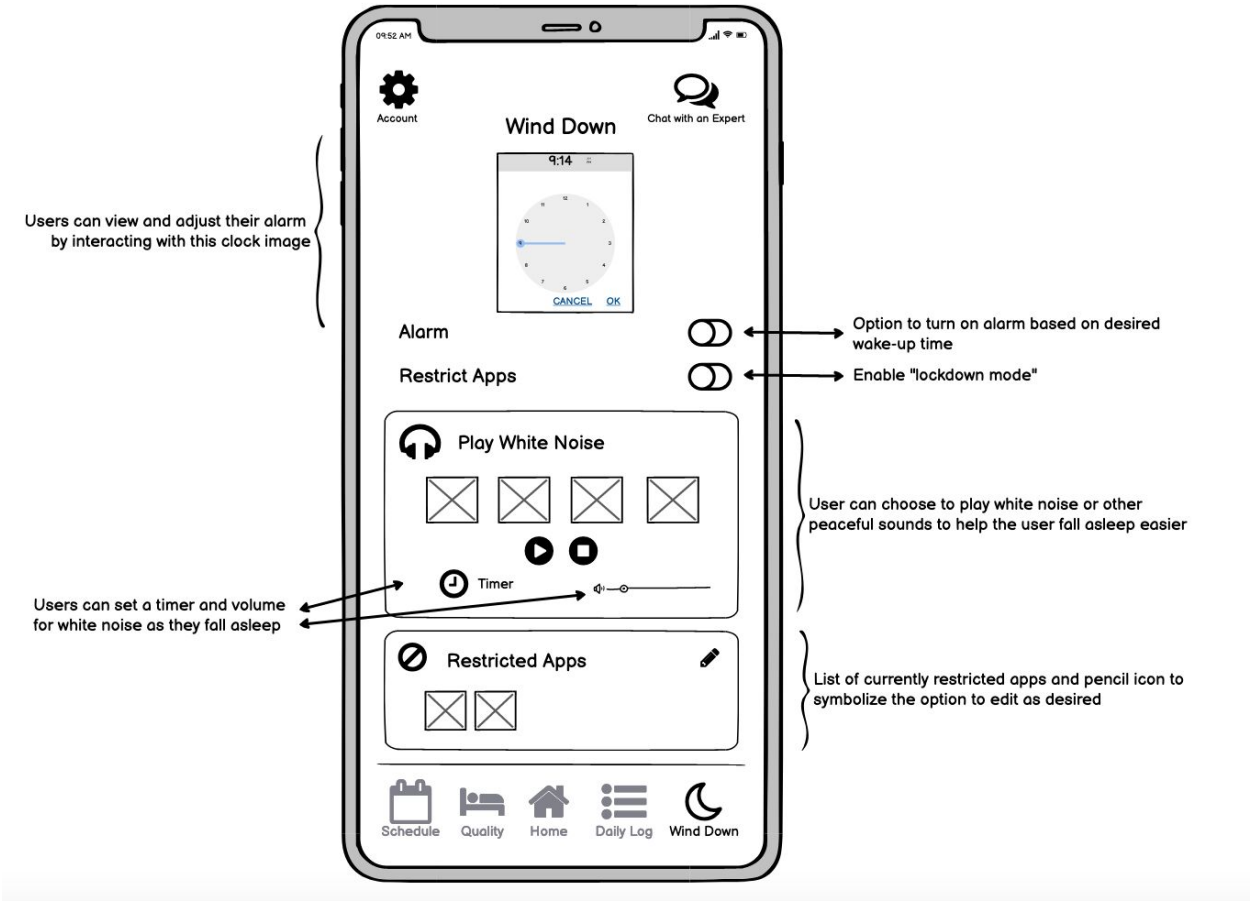


Fig. 19: Final low fidelity wireframe for the user using the Wind Down tab before sleeping

Screen 7: Sleep Quality

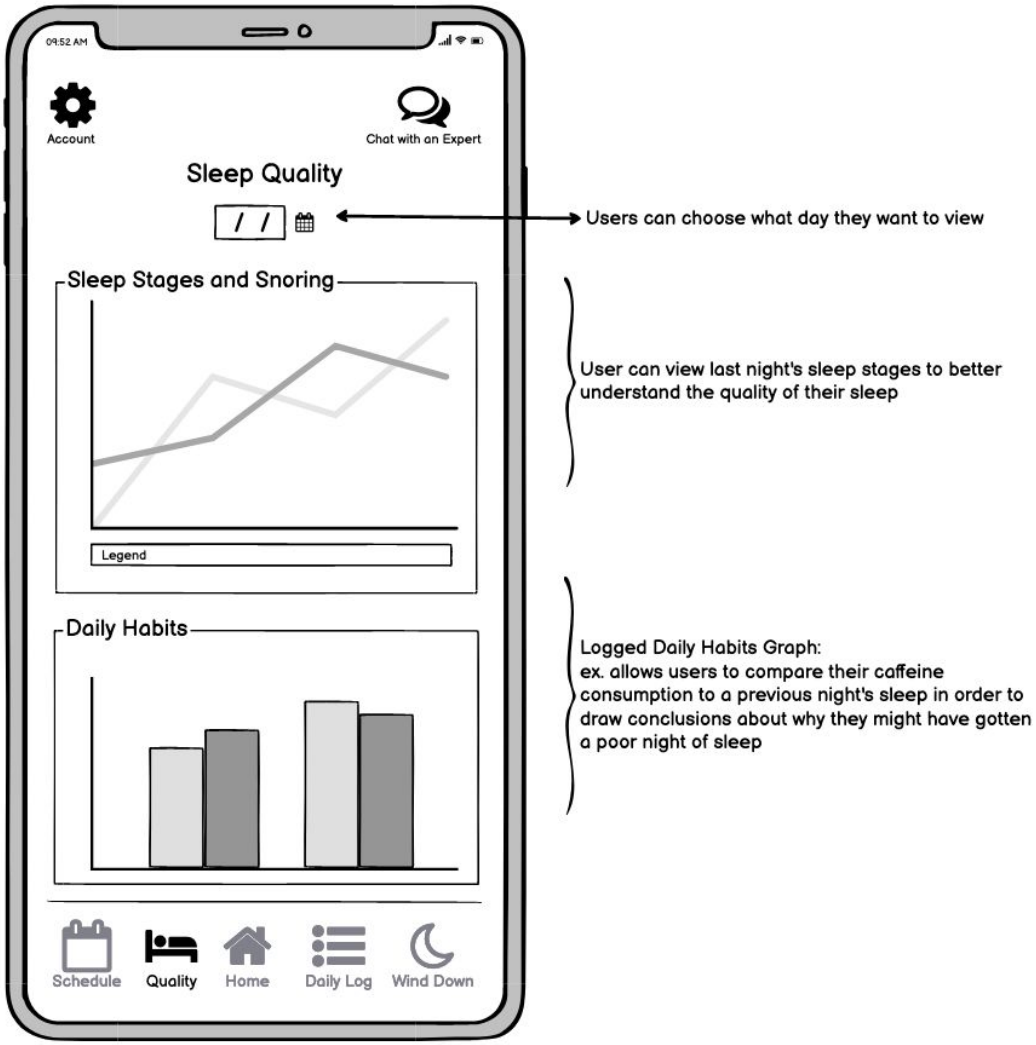


Fig. 20: Final low fidelity wireframe for user viewing past nights' sleep quality and trends in daily habits

Usage Scenarios

Usage Scenario 1: Generate an optimized sleeping schedule

Emily Clarke has tried everything she can to improve her sleep quality due to heavy schoolworks. As time approaching the end of the quarter, she heard about the GoodNight app which comes with a wristwatch to generate the best sleep schedule for her. She was very excited to try the new app. She downloaded the app and synced it with her Apple Watch which she was already wearing.

The first thing she did using the app was upload her schedule. From the homepage, she clicked on the 'Schedule' tab and then the 'Import Calendar +' button to import her Google Calendar schedule into the app. After uploading, she can clearly see the area representing her work shaded gray. She notices that the schedule is also now populated with blocks of sleeping time that the app has generated for her based on her activities.

The next thing she did was go back to the homepage and set up her goals from the 'My Goals' icon located in the upper middle area. She entered several goals including sleep 7 hours per night as a short-term goal and increase sleep quality as a long term goal. After finishing writing her goals, she gets a popup to confirm that her sleep schedule will get optimized. She clicks "Yes" to allow the app to make any additional changes. When Emily goes back to the Schedule tab, she sees that her recommended sleeping time has slightly shifted by about 15 minutes earlier to accommodate her goals.

At night, Emily clicks on the 'Daily Log' tab to fill out her current day's activities. Emily consumed two cups of coffee in the morning to fight yawning, so she clicks the increase button for caffeine two times to represent the amount of caffeine she consumed today.

After a few days, Emily has noticed she is having more energy during the day and was able to cut down on caffeine as well as improve on her latest exam. When she opens the app and clicks on 'My Goals' again to see her progress in the progress bar, it has now shifted to display 50%. Emily found this app super helpful as she now has increasingly more energy to accomplish her academic goals.

Usage Scenario 2: Getting Recommendations from an Expert

Alex had been using GoodNight for a while, he had been following all the tips the app recommended him based on his habits and the data from his Fitbit. He had been going to bed at the same time every night, he was avoiding coffee and alcohol. Despite following these recommendations, when he tried to go to sleep at night, he always found he was unable to fall asleep, and often only got 2-3 hours of sleep a night. One night after about an hour of lying in bed trying to sleep, Alex decided to try the "talk to an expert" feature he had seen in the app. The next morning, he opened GoodNight, and tapped on the speech bubble icon in the upper right corner that denotes the "Chat with an Expert" feature. A pop-up asked him for his permission to share the data the app has collected with the expert he's about to talk to. After confirming, A chat window appears. The expert introduced themselves and asked Alex what he wanted to talk about today. Alex explained how he was following the recommendations the app was giving him, but he still couldn't get to sleep at night. The expert took a look at Alex's data, and asked Alex a few more questions. In the end, the expert recommended that Alex talk to a doctor about possible insomnia. Alex did talk to a doctor and was diagnosed with Insomnia.

Bibliography

A. (2020, January 27). *College students: getting enough sleep is vital to academic success*. American Academy of Sleep Medicine – Association for Sleep Clinicians and Researchers. https://aasm.org/college-students-getting-enough-sleep-is-vital-to-academic-success/

American Academy of Sleep Medicine (AASM) (2017, November 6). Importance of Sleep & Effects of Sleep Deprivation on College Students. Retrieved November 4, 2020, from https://aasm.org/college-students-getting-enough-sleep-is-vital-to-academic-success/

American Sleep Association. (2019, June 1). *Sleep Doctor: Sleep Disorder Specialist*. https://www.sleepassociation.org/health-professionals/sleep-doctor/

Do Sleep Trackers Really Work? (2020, October 20). John Hopkins University. https://www.hopkinsmedicine.org/health/wellness-and-prevention/do-sleep-trackers-really-work

Lambert, J. (2019, May 8). *How Important Is Sleep to Academic Success?* CollegeXpress. https://www.collegexpress.com/articles-and-advice/majors-and-academics/articles/study-smarter/how-important-sleep-academic-success/

Leaf Science Editorial Team. (2019, July 10). *Can Marijuana Help With Insomnia?* Leaf Science. https://www.leafscience.com/2017/11/24/can-marijuana-help-insomnia/#:%7E:text=Marijuana%20can%20help%20you%20fall%20asleep%20at%20night,less%20effective%20as%20the%20user%20develops%20a%20tolerance.

Sleep and Memory | Need Sleep. (2008, December 16). Division of Sleep Medicine at Harvard Medical School. http://healthysleep.med.harvard.edu/need-sleep/whats-in-it-for-you/memory

Sleep problems in university students – an intervention. (2020, October 20). PubMed Central (PMC). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5536318/

Suni, E. (2020, October 01). Interrupted Sleep - Causes & Helpful Tips. Retrieved November 04, 2020, from https://www.sleepfoundation.org/articles/interrupted-sleep

University Health Center | Managing Stress | Sleep | University Health Center. (2020). University Of Georgia. https://www.uhs.uga.edu/sleep#:%7E:text=On%20average%2C%20most%20college%20students,our%20GPA%20and%20our%20safety

Project Icon: https://www.freepik.com/free-vector/flat-icons-sleep-time_4407651.htm

Appendix

Stakeholder Interview Transcript

Q: What year of college are you in?

A: I am a junior studying Computer Science.

Q: What kinds of activities do you do outside of class?

A: Outside of class I TA for Human Computer Interaction course in the CSE department,t i"m the chair of ACM which is the largest student run organization in the Allen school, and I bake, and I am part of a research group on campus.

Q: How much time does this take up?

A: Probably about 15-20 hours per week.

Q: Could you tell me about your current sleeping habits?

A: Currently my sleeping habits - I sleep between 2 and 4 am, and I wake up between like 9:30 and 11 AM? It all depends on what I have scheduled and how tired I feel.

Q: What do you usually do before bed?

A: Before going to sleep I'm usually doing homework. Well, it depends on the day. If it's a school night then homework but on the weekend it's usually a social call with friends over Zoom.

Q: How easy is it for you to fall asleep?

A: I fall asleep very easily. Some days I have trouble but it's probably because I had something on my mind. But other than that, I usually fall asleep very quickly.

Q: How do you usually wake up? How easy or difficult is it?

A: I usually hear my alarm in the morning, turn it off, or hit snooze, wait for my second alarm, and then if I don't have anything super pressing I pick up my phone and check my notifications, and only then get out of bed and get ready for the day.

It's pretty difficult to wake up. It's extremely difficult actually. I'm extremely tired and I don't want to open my eyes. Since my schedule gives me free time in the morning, I don't have a lot of motivation to get up too early. Honestly, I think that's also part of the reason why I stay up so late...because I know I won't be able to get up early enough to do those things.

Q: How have your sleeping habits changed over the course of your undergraduate career?

A: My sleeping habits - in high school because I had to wake up at 6:30 to go too school, I slept earlier but I slept less. I slept around 12:30am and woke up at 6:30pm which is about 5-6 hours. Now I sleep around 7hrs on average. That being said I do still feel tired, I don't know if it's more tired than in high school, but I know I should get more sleep.

Q: How satisfied are you with your current sleeping habits?

A: I'm not very satisfied with my current sleeping habits - I think I should be sleeping more because I'm always tired. That being said, I don't think I have the self control…

I feel like if I manage my time better and set more strict limits on when I go to sleep, then I could probably fix it more, but either there's always just more stuff that I could be doing or I don't want to which prevents me from going to sleep early.

Q: How do you think your sleeping habits affect your performance in school?

A: I think that if I slept more, I would be able to pick up on classwork faster which is a problem, low key. I think that I would be more alert in general because I'm usually tired and don't pick up on a lot of things. I could technically also be more productive, but again, I don't have a lot of self control...but I would definitely have more energy.

Q: How do you feel about sleep tracking apps and/or devices?

A: Um...I think that they're ok,. but like you can control it every day. I use Apple bedtime. It's not that correct. It tells you that you wake up when your alarm rings but I don't actually wake up. They're all ok, I just don't know if it would work for me. Again, since I don't know if I am motivated enough. A lot of people say I'm externally but not internally motivated. If someone else or something else is telling me to do something, especially if I am held accountable for something important. Something I know I can change and have control over, would be harder for me to stay motivated.

Interview 3 Transcript

T: Hi Kim, tell me about yourself.

K: I am Kim, I am senior in UW, currently major in Math, and minoring in CFRM. I prefer he/him pronouns.

T: How much sleep do you average get per night?

K: Usually around 6 -7 during weekdays, more than 8 hours on weekends.

T: Tell me about the differences with your current sleeping schedule and your sleeping schedule in 2019.

K: In 2019, I usually go to bed around 2 or 3 am after going back home from Ode, and my wake up time depends on if I have a morning class or not, if I do, I wake up at around 9am, if I don't, I wake up around 10. And in 2020 because of the virus, I don't have a set sleeping time, but during these months, I sleep around 7 to 8 am.

T: Could you please elaborate on your sleeping schedule? What did you do to moderate this situation?

K: I went back China at March during spring break. Before I going to China, I registered class around 8 am to 11:30 am, and in this case I can go to live lectures first and then go to bed.

T: How do you feel about it?

K: Its really tiring because I have already get used to the schedule study in Seattle, I have studied here for three years, since I am a senior, I have a lot of work to do, including applying for master's degrees and apply for internships. It is very tiring because I have to manage my schoolwork and get used to the jet lag, send emails to professors at appropriate time to ask for recommendation letters and also getting connections with my intern managers and my classmates in Seattle. Sometimes if I forgot to go to live lectures it is very time consuming for me to get immediate feedbacks, and it's a waste of time. I can still get enough sleep during the day, but I always feel kind of tired.

T: How do you feel about sleep tracking apps and/or devices? Have you used them before?

K: I have used one sleep tracking app before when I was in china during high school, I forgot the name tho, it was probably developed by Chinese developers, It was not quiet useful because when I tried to track back my sleeping quality, I did not get much information and how to enhance the quality of my sleep. What's more, I don't get a unified trend of my sleeping quality based on that app, and I quitted using the app few days later.

T: Okay, what do you think should be improved in the device you have used? Please explain.

K: I feel like if it is personal enough and it can put all my schedule and personalize it for me, to help me to see when can I get enough time of sleep, and the time I need to get my work finished based on my schedule, and if it can tell me a trend when is the most qualified efficient sleeping time for me in a day. If it can do that, it is helpful for me.