DECO3800

Milestone 1

Problem Identification

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9-2-2024

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Overview

University students often experience sleep deprivation due to the challenges of balancing their academic responsibilities, leisure activities, employment and social life, this is compounded by bad habits such as internet addiction and stimulate use and further worsened by poor mental health. The consequences of sleep deprivation can be significant, with a wide range of negative impacts on various aspects of life, both academic and personal.

When discussing sleep in a general manner, two key concepts are considered: sleep quantity and sleep quality. Sleep quantity refers to the amount of sleep a person gets each night, typically measured in hours and is a straightforward metric. Sleep quality, on the other hand, is more qualitative and encompasses several factors, including sleep's physical and psychological effects, its depth, and how quickly one is able to enter it. There are countless variables of varying prevalence across all walks of life that have the potential to disrupt or influence the quality and quantity of one's sleep, the vast majority not exactly being exclusive to one demographic alone, thus a honed and specific target audience is necessary when looking to possible commonalities.

As such, the overall aim of this problem identification report is to explore the more common/outstanding issues related to sleep, faced specifically by Australian university STEM students, as well as to identify any design directions for solutions to improve the quality and quantity of the sleep they get.

Background reading/literature review:

Problem Research

University Students and Sleep

University students are experiencing insufficient sleep. This fact is highlighted by (Batten R, 2020) where it found 33% of students sleep less than 6.5 hours a night, similarly in the American study (Hannah G. Lund, 2010) that surveyed 1125 university students and found 60% had poor sleep quality and again in (Gallego-Gómez, 2021) shows that poorer sleep habits negatively impact academic performance. The study also affirms that normalization of evening habits in students lead to sleep deficit and influence quality of sleep.

The relationship between students' sleep quality and academic achievement is again clear in research. It shows a significant association. (Seun-Fadipe CT, 2017) highlighted the negative impact of poor sleep quality on academic achievement in Nigerian undergraduates. Emphasizing the important role of sleep in biological functions, (Ahrberg K, 2012) further supported this idea by showing a link between sleep problems and poor academic achievement.

(Okano, 2019) analyzed how sleep quality, duration, and regularity directly contribute to improved academic performance. These results suggest that maintaining consistent sleep patterns is important for improving cognitive abilities in college students.
From these studies it is evident there is a systemic problem with university students and poor sleep quality and how this poor sleep quality measurably impacts academic performance.

Sleep Quality and Health

Our background research suggests that Sleep has an extensive link with overall health. This fact is highlighted by (Hirotsu, 2015) where they explored the complex relationship between sleep, stress, and metabolism. The study showed that sleep disorders can lead to metabolic and physiological stress. This ultimately affects alertness and overall health.

The link between sleep and health is further emphasized by (Goldstein, 2014) where they explored the important role of sleep in regulating the emotional function of the brain. They link sleep quality to mental alertness and emotional stability. Their research shows that sleep not only helps restore cognitive abilities. But also maintain emotional balance. How important is it for the overall benefit? (Chang et al. 2015) conducted extensive research on the effects of sleep on attention and cognitive function, and the results showed that using luminous electronic books at night disrupts sleep patterns and heart rhythms. This leads to decreased alertness the next morning. This emphasizes the importance of the sleeping environment and daytime work habits.

The link is again supported by a study by (Kudrnáčová, 2023) that investigated the impact of sleep on life satisfaction. And it was found that improving sleep can improve overall quality of life. This will indirectly help support academic success.

Factors that affect sleep

(Feifei Wang, 2021) is a literature review of risk factors for poor sleep. It includes 112 studies which were classified into categories based on the studied risk factor. And found that caffeine, stimulants, alcohol, internet addiction, irregular sleep patterns, poor mental health and poor social relations decreases sleep quality.

(Toscano-Hermoso MD, 2020) studied gender differences in sleep quality. Their study found that women reported poorer sleep quality than men. The study also showed a link between gastrointestinal problems and poor sleep quality. This study supports the development of prevention and education programs before optimizing sleep patterns in people at high risk for sleep disorders.

These studies outline how sleep quality has many factors and many factors outside of routine and ones that someone does not have directly or any control over such as mental health and gender.

Manners of Improvement:

(Gallego-Gómez, 2021) showed that sleep intervention is an intervention to change nighttime habits and promote good sleep. It has been shown to be very important for improving academic quality and outcomes.

One way to help with falling asleep that has been gaining popularity is by listening to white noise before sleeping. (Samantha M. Riedy, 2021) explores the relationship between using this method and sleep quality. The study found that the quality of evidence for white noise improving sleep is very low. Additionally, the study also highlights that introducing continuous noise to the bedroom environment may disrupt sleep or induce hearing loss.

Existing Solutions

There are existing digital solutions that address common sleep-related problems. These solutions were investigated in order to identify which issues have been addressed, through what means, and to evaluate their success or shortcomings.

The Apple Watch (Apple) is a smart watch with the capability to capture sleep data and implement a sleep schedule for its users. With a simple, small interface the device captures and displays data describing sleep duration, sleep stages, heart rate, motion during sleep and more. This technology could be useful for students who rely on knowledge of their body's processes in order to better understand their sleep cycles. Apple IOS supports a 'sleep sleep focus,' which implements settings to reduce notifications and distractions before a user's specified bedtime in order to reduce screen time before bed. This vaguely addresses the common issue discovered in both our academic and user research.

For Apple's features to be utilized users would need to invest in an Apple watch, which for university students, may not be financially feasible. Additionally, the sleep focus feature does not address the common issue of 'late night thoughts,' and students can easily ignore the suggestions of the application.

'Sleep Ninja' (Black Dog Institute, 2024) is a free mobile application developed by the Black Dog Institute which aims to help young people aged 12-16 years old address mild to moderate sleep difficulties. The application is recommended to be used for approximately six weeks where users work through six learning modules, input data relating to their sleep, and have access to personal guided routines. The application may be effective in addressing some of the problems in our user base such as lack of knowledge about sleep and tracking consistency. Additionally, the application has optional features such as relaxing audio and reminders to wind down before bedtime, which may be effective in addressing late night thoughts, and screen time before bed.

Because the application is aimed at a younger audience it may not be engaging or suitable for university students. It does not address the common scattered schedules of university students, or how challenging STEM coursework can affect a student's ability to wind down. However, the application is a valuable example of how a free mobile application can be used to address sleep issues.

Stakeholders

Primary Stakeholders

The primary stakeholders identified in this problem space are university STEM students in Australia, as they will be the target user-base for our solution. The aim is to develop a solution to address the issues faced by university students identified in the above research. Engaging with these students during the design process is essential to ensure the solution meets their needs. The success of such a solution could improve the student's academic performance and health.

While the solution is intended to benefit students, there is a risk that it could be misused as a replacement for professional medical advice or treatment. It is crucial that this key stakeholder group understands the appropriate use cases for our solution and recognizes when to seek professional medical help for sleep-related issues.

Secondary Stakeholders

Medical professionals or field experts have been identified as secondary stakeholders. It may be to the detriment of professionals if students utilizing the solution neglect treatment where necessary, lessening the demand for such services. Contrarily, if the proposed solution is successful, it may be recommended by professionals to students or others as a supplement to professional treatment which may be to the benefit of both stakeholder groups. Additionally, our solution could potentially be integrated into current treatment plans, enhancing the effectiveness of medical care.

Potential Stakeholders

University faculties or administration may also support such a solution should it lead to healthier, more productive students. If the product is able to noticeably improve student wellbeing or academic performance, it may be recommended or endorsed by academic institutions. Furthermore, if the solution proves effective, it could be extended to the workforce. Employers might then take interest, as it could enhance productivity, workplace culture, and employee well-being.

User research:

To better understand the target audience, we began a user research phase focused on understanding the quality and quantity of sleep among college students. The goal was to identify key issues and possible solutions in this area. In particular, psychological factors, behaviors, and habits that affect sleep.

Regarding user research, an initial run of 6 pilot interviews were conducted on university student participants, in order to get a general grasp on some of the potential problems and solutions associated with the domain of sleep quality and quantity.

A simple interview protocol was created such that the answers gained were consistently relevant, with the questions involved mainly prompting users to provide details of their sleep schedules and the habits and consequences surrounding them. As such the primary aim of the protocol was to elicit and identify surface-level patterns regarding sleep quality and quantity in the target demographic specifically.

The interviews were structured using a carefully designed protocol to produce consistent and relevant responses. Questions focused on sleep schedules, habits, and how this affected students' sleep patterns.

Interview Protocol Highlights:

- What is your typical sleep schedule on weekdays and weekends?
- How often do you find it difficult to fall asleep? What do you think causes this problem?
- Do you use electronic devices (phones, laptops, etc.) before bed? How do you think this affects your sleep?
- How do your responsibilities (e.g., college, work) affect your sleep schedule?
- What strategies do you use to improve your sleep quality?

From the results gained from the conducted interviews, there were numerous identified key variables associated with positive/negative sleeping patterns, though they weren’t all necessarily specific to university students.

Some of the most important conclusions made however were that:

- Late-night thinking and anxiety: Many college students report having late-night thinking, which is often associated with anxiety and difficulty concentrating. It affects your ability to fall asleep on time.
- Use of technology like phones/computers/laptops could impede timely sleep, linked primarily to a lack of self-control and discipline (social media, YouTube, etc).
- Obligation was an important factor when considering a "sleep schedule" and in maintaining consistency. Obligation could be both beneficial and detrimental to timely sleep. Obligation primarily being associated with university class timetables as well as work/life responsibilities.

- Some individuals' sleeping habits could be more “circadian rhythm” based, only deciding to fall asleep when they feel tired. With circadian rhythm misalignment also being a prevalent factor in lack of sleep. A consistent circadian rhythm is intrinsically linked to a sleep schedule’s efficiency.
- Students may know that "not enough sleep is bad" but may not fully comprehend its negative consequences and importance especially relating to their cognitive ability. (Students staying up and ruining their schedules for finals)
- Having ambient noise at night could positively influence the speed of sleep, preventing negative thoughts from spiraling.
- Dedication and consistency: Commitments such as college course schedules and work responsibilities. It's a double commitment. This can help you maintain a consistent sleep schedule, but it can also be disruptive. This is especially true as deadlines approach.

The study showed that the main issues affecting students' sleep are related to responsibilities, habits, behaviors, and perceptions, which are deeply rooted in psychology. This suggests that any solution aimed at improving sleep quality must take these psychological aspects into account.

Comprehensive academic research strengthens the relationship between student psychology and sleep quality. This consistency suggests that solutions involving cognitive or psychological interventions may be particularly effective.

Though from the discussions had, and conclusions drawn, most of the more prevalent ideas and issues related to the act of “maintaining a sleep schedule” or “going to bed on time” seemed to be primarily associated with the concepts of, responsibility, habit, behavior(discipline) and notion all of which lying rather firmly in the realm of the mental.

As such when crossed with the found academic data referencing the correlations between uni student’s mentalities/behaviors and sleep quality, it can be seen that with regards to the domain/nature of a solution, a concept that influences perception or behavior could be particularly helpful.

Regardless, due to the small sample size, many more rounds of interviews with specific and honed questions would be prudent in order to affirm and deduce more patterns. Further qualitative research methods would also be beneficial, e.g. autoethnography, for attaining diverse insights.

Possible Design Directions

At the current stage the problem space is too broad to have a singular design direction, with this section being more design ideas that could be applied further down the line when given a more concrete target problem.

The initial design ideas seek to educate users this can be done in two distinct manners. The first is outlined in existing solutions and is the use of sleep tracking, this would help educate users about their personal sleeping habits and measure their sleep quantity & quality. This could be done through more elaborate sensors and tracking technology aiming to enhance the usefulness of gathered data and compiled insights.

The next is a more general form of sleep education to provide a design solution that helps educate users about sleep in general including information on adverse effects on poor sleep along with upsides and manners of improvement.

The next set of ideas seek to address the cause of the sleep deficiency. From the user and background research the most frequent causes of poor sleep quality among university students included: internet addiction, poor mental health because of academic stress and use of stimulants.

These issues are all much bigger than poor sleep and would require further specific research, but some initial preliminary ideas include a digital design that seeks to have a user meditate or a similar wellness/selfcare type routine to induce downtime before bed. With another design idea being around habit changing to disturb poor sleep practices and improve sleep quality.

Ethical considerations:

The scope of developing a digital solution to improve sleep can be large and will include many different aspects of ethics that need to be considered and many will be solution specific. This section first covers the main areas of attention that will be accounted for when making an ethical design.

The first is user data privacy (Falbe, 2018), at minimum any design will need to adhere to any relevant country specific regulations such as the Australian Privacy Act or the European General Data Protection Regulation (GDPR). These regulations establish baseline requirements for areas such as data collection, protection against data breaches and explicit user consent before collecting data. These regulations lay a strong baseline for any privacy related ethical considerations but notably do not by themselves necessarily constitute an ethical design.

On top of the ethics of data privacy any solution should adhere to elements of ethical design (Asscheman, 2024) this requires being user focused to the intended user audience. This user focus will require in-depth knowledge of the audience (Dagfinrud, 2024) and ensure that any design caters for this audience along with ensuring that the design is actually able to perform its intended solution and properly solve the intended problem.

The next aspects of an ethical design are requirements for usability (Asscheman, 2024). This is an important aspect for inclusive design and seeks to avoid overly bearing design aspects that can make a design cumbersome. The next is accessibility, this aspect of design seeks to avoid isolating groups of the intended audience. Both Usability and Accessibility will require targeted user testing for different aspects of the solution.

Lastly for a design to be ethical it should account for broader considerations of societal impacts (Asscheman, 2024). This focuses the designs impact on the world’s environment, resources and climate and will require considerations about a solution/products lifecycle and its resultant impacts.

While not comprehensive these 5 aspects of Privacy, User Focus, Usability, Accessibility and Societal implication will be a baseline for any design to be developed and judged. Along with this any user interactions through development should be conducted ethically, this will require that research and testing that includes users is done in an ethical manner relating to privacy and intrusiveness of inquiries and tests, along with any specific ethical concerns of a given test subject/group.

Given that poor sleep quality can relate to a multitude of factors it is certain that no one design will be a comprehensively cover all cases, further these multitude of factors span a plethora of problem areas, to name a few examples of a potential cause and the related discipline

- Internet addiction relating to habitual behaviors
- Chronic health issues relating to the medical field
- Mental health issues relating to psychological fields
- Sleep Disturbances due to ongoing conflicts relating to political affairs
- Inability to access suitable sleeping space relating to poverty

This introduces the ethical concern of providing an ill fit solution to a given cause to ensure that the design is correctly targeted any design will need to be made specific to address only a subset of causes, this is important as it would be unethical to provide an ill fit solution to a situation. And in the worst case an ill fit solution could lead to further detriments of the ongoing cause, such as the use of an extensive sleep monitoring system (with data being relayed to non-government entities) for a person with poor sleep due to schizophrenia.

Questions/areas of investigation

From our background research, although we have identified some behaviors that negatively impact sleep quality, such as using technology before sleep or normalization of evening habits in students, further research is needed on the reason for these behaviors. Future research could investigate how prevalent technology use before bed is and the factors related to technology use before bed in students. Furthermore, although we have explored the relationship between students' behavior and sleep quality, we have not fully explored the relationship between the sleeping environment and sleep quality. We could look into how factors such as temperature, noise level, room brightness, etc. affects sleep quality

According to the interview we already did, some results show that university students do have a sleeping schedule for what time they should go to bed. However, most of them will delay the schedule because of using technologies. This means they don’t need to strictly follow their sleep schedule. Therefore, in future data collection, we need to understand how participants determine how much sleep they need and under what circumstances they allow themselves to deviate from their original sleep schedule.

As students, the main goal in their current daily life is to achieve pass or high grades for study. We already see that the University of Queensland has changed the deadlines for assessments from midnight and morning to afternoon, because of preventing students from staying up late to do homework. What we still need to be concerned is whether it helps students to have more sleep or students still need to sacrifice their sleep for assessments & review for examinations.

Most existing solutions are mobile apps, but technology also is a problem for maintaining sleeping schedules. In the further design process, we need to figure out if there are better types of solution than mobile apps. If nonphysical solutions can instead of apps, what factors caused by technology could affect original sleeping schedules need to be identified.
If possible, we would like to find participants who used those existing solution apps before. Asking them what functions are efficient for maintaining sleep schedules, and whether they still use those apps and why they stop using them.

Further Research Questions:

- How do university students perceive their need for sleep?
- How do academic demands and deadlines impact students' sleep schedules and quality?
- What are the most common strategies students use to balance academic workload and sleep?
- How does the use of electronic devices before bedtime influence students' ability to fall asleep and maintain a regular sleep schedule?
- How do students perceive the impact of late-night technology use on their sleep quality?
- What barriers do students face when trying to improve their sleep habits?

Project plan

1. **Further Interview**
    - **Task Description**：Design and implement in-depth interview, having detailed discussions with participants for their sleeping challenges and coping strategies.
    - **Date**：28th august – 4th September Week 6
2. **Group discussion (interview results)**：
    - **Task Description**： Share the interview results with team members, analyse the potential needs of the participants, and iterate on the data collected in the previous round. Summarize potential coping strategies.
    - **Date**： 5th September – 13th September week 7
3. **Implementing Sleeping Diary**：
    - **Task description:** Ask participants to record their sleep patterns for a week, take notes for their routine before sleep (Recording mood and last activity they did before bed).
    - **Date**： 16th September – 22th September week 8

4. Case study：

- **Task description:** Developing case study for students who are facing significant sleeping challenges**.** Explore relationships between each factor (personal factor, social activity, school work and exercise etc.)
- **Date**： 23th September – 29th September week 9

5. Comparative Analysis：

- **Task description**： Compare the sleep challenges and experiences of different student groups (e.g., local vs. international students, students living on campus vs. students living off campus).
- **Date**： 30th September – 6th October week 10

6. Proposal for potential solutions/directions：

- **Task description**： list main solution/s which are agreed by team members. Indicate potential solutions and directions that could be developed in the future.
- **Date:** 30th September – 8th October week10 - week 12

Project Risks

Insufficient user or academic research could lead to low engagement with the solution from our target audience, or a product that fails to address the main concerns we have identified in our research. This may be due to lack of relevance, usability or effectiveness. This is one of the main risks to the project's success, as our aim is for the solution to be used and effective for STEM students. In order to mitigate this risk, thorough user research must be conducted across a range of STEM university students, ensuring the needs of a wide audience are met. This is why we will be iterating the interview process to cover a wider user-base and implementing new data collection techniques such as the sleep diary.

The collection of sleep data or otherwise may pose concerns about data privacy and security, which is an important ethical consideration in our project. To mitigate this, it is imperative that we collect the consent of all users, ensure they are informed about the use of their data, and design into our solution robust data protection methods such as encryption and anonymisation.

The project must be completed before a specified date, placing it under a time constraint. Insufficient time management would put the project at risk of being incomplete by the time of the due date. To mitigate this, a thorough project timeline will be followed, and there will be milestones in place to ensure sufficient progress throughout the timeline. Tasks will be prioritized based on importance, and members of the project will be delegated tasks to suit their schedules.

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