Design Thinking and a Human-Centered Approach to Explore the Potential of Mobile Phone and AI-Enabled Just-in-Time Mental Health Solution for University Students in India

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Abstract: Anxiety, stress and depression are the significant mental health and well-being challenges being faced by the university students, early one in three reporting significant struggles. Academic pressure, family expectations, a competitive environment, social isolation, financial stress and stigma surrounding mental health contribute to this issue. These challenges impacts students' academic performance and social integration negatively, which further impacts their mental health and well-being. Given high mobile phone usage among youths, smartphones offer a unique, discreet avenue, for mental health support. By leveraging device sensors like accelerometers, gyroscopes, GPS, proximity sensors, and biometric readers (e.g. heart rate, SpO2), a mobile framework can analyze user activity pattens, social interactions, and screen time to detect early signs of mental health concerns, such as stress, anxiety or loneliness. Integrating this data with trained mental health models enhances predictive accuracy, enabling personalized help and therapeutic content like calming music, mindfulness exercises, or relaxation videos, Notifications, and chat bot conversations as a virtual buddy, tailored to their preferences. The framework uses smartphones as an unobtrusive wellness companion, aiming to prevent mental health deterioration while safeguarding, user privacy, thus empowering students with a personal tool for mental health well-being.

1 INTRODUCTION

The prevalence of significant mental health disorders, especially stress, anxiety, and depression, is rising manifold among college students. They face many challenges, including academic pressure, social isolation, and the stigma around seeking help (Hunt and Eisenberg, 2010), all of which can affect their ability to manage stress and anxiety. According to the World Health Organization (WHO, 2020) report, mental health conditions in this population are increasing at a rapid pace, with nearly one in every three students experiencing mental health difficulties. Approximately 40 of students in India reported symptoms of depression, and up to up to 70% of students reported stress and anxiety (Dutta et al., 2023). Loneliness has been identified as a strong predictor of depression and anxiety(Richardson et al., 2017), and may negatively impact both academic performance and social adjustment to the university environment (Danneel et al., 2018). A survey in the UK found that 34% of students aged 18–24 felt lonely to some degree (Venkatesh et al., 2015). The transition to digital learning modes has increased the mental health burden due to factors like increased screen time, time, reduced physical interaction, and the pressure of adapting to new technologies (Eisenberg et al., 2009). As per the National Crime Records Bureau (NCRB) 2022 report, young adults aged 18-30 years accounted for 35% of all suicides in 2022; NCRB statistics also indicate that, one student committed suicide every hour (Reddy et al., 2018) (Kemp, 2023), highlighting the urgent and critical need to address mental health conditions among this population.

1.1 Design Thinking and Human-Centered Design in Mental Health and Well-being

Design Thinking (DT) and Human-Centered Design (HCD) are steadily more acknowledged for their re-

markable contributions to the design and development of mental health well-being solutions that serve users' specific needs, particularly in navigating the challenges of seeking mental health support. Empathy is the core of the DT that enables designers to gain mental health and well-being concerns from the end user's perspective. In their research, Brown and Katz, 2011, illuminate DT's effectiveness in fostering creative problem-solving by prioritizing the emotional experiences of users and addressing critical barriers such as stigma, accessibility, and user engagement. The close alignment of Human-centered design (UCD) and Design Thinking (DT) make sure that the solutions are accessible, easy to use, and responsive, leading to higher trust and usability (IDEO, 2015). Improving the features and enhancing user engagement and satisfaction with digital mental health and well-being solutions, as well as iterative testing and feedback loops, can contribute very effectively (Torous et al., 2018).

1.2 Mobile Usage Behavior Among Students and Mental Health

Mobile phones are the widely adopted technology globally, playing a central role in our daily lives across the population, and university students make up a significant portion of mobile phone users. University students living in hostels spend considerable time using mobile phones for communication, browsing the internet, social media, and entertainment. As of early 2023, India had 1.10 billion active cellular mobile connections, representing 77.0% of the total population (IMRB, 2016). The Mobile Marketing Association, in collaboration with Kantar (IMRB, 2016), reported that the average consumer spends 3 hours a day on their smartphones, exceeding the time spent on television and other forms of media (Carbonell et al., 2012). Many young people admit to never turning off their smartphones, keeping them by their side while they sleep, and compulsively checking them throughout the day (Griffiths and Kuss, 2017). A growing body of research investigates the relationship between mobile phone usage and mental health outcomes. Although mobile phones are valuable communication and social connection tools, excessive or maladaptive usage can contribute to mental health issues. Many studies have reported that higher mobile phone use, especially in the context of social media, is linked with enhanced levels of anxiety, depression, and stress among university students (Tarafdar et al., 2015).

1.3 Mobile Phone, AI & Mental Health

While mobile phones can add to mental health problems, considering the limited availability of mental health professionals, and the limited accessibility of mental health care in remote and rural areas (Chandrashekar, 2018), they possess considerable potential to provide adequate mental health interventions (Ahmed et al., 2021). Mobile-based interventions, such as mental health and well-being apps, have gained popularity as a means of providing accessible and scalable support to university students. Artificial Intelligence (AI) is gradually being acknowledged as a critical technology for diagnostic , assessment, intervention, and real-time support in mental health and well-being. Several empirical evidence indicate that (AI)-driven applications and systems can refine the assessment and diagnosis of mental health disorders, deliver real time and personalized interventions, and help in mitigating the stigma associated with coping and seeking mental health help. Research has proven that AI-powered chat-bots, such as "Woebot", effectively lessen the symptoms associated with anxiety and depression (Fitzpatrick et al., 2017). AI tools offer a higher degree of personalization that traditional therapeutic methods may struggle to match, particularly in under served populations(Jacobson, 2022).

Integrating mobile phone technology and AI has a very high potential to reshape the access and delivery of mental health treatment fundamentally. In the past decade, mobile applications focused on mental health have surged in popularity and are beginning to be utilized in university environments as a valuable resource for supporting and addressing mental health issues among college students. Indian universities, with limited availability of mental health resources, can leverage the mobile-based mental health and well-being interventions to bridge the gap between students and professional help, however, user engagement, cultural relevance, and the quality of the app content will decide the effectiveness and success of these interventions (Firth et al., 2017). Tailoring the system for diverse cultural contexts and individual differences is challenging (Torous and Roberts, 2018) More research is needed to explore how mobile mental health interventions can be tailored to university students' specific needs and challenges in different cultural contexts.

2 METHODOLOGY

Applying Design Thinking and Human-Centered Approach, this research project explored the potential for

a Mobile Phone (Smartphone) and Artificial (AI) enabled Mental Health and Well-being solution for university students in India. This approach started with engaging with all the stakeholders and understand them using the mixed method approach including user survey, interviews, expert interviews, and technology review to answer the research question: ***Can Smart Phone enabled with AI Support Mental Health Well-being among university students in India?***

9The research study stared with identifying the stakeholders including people (University Students, Mental Health and Well-being's Experts) and technology involved (Hardware and Software of Mobile Phones and Artificial Intelligence, in the Eco-system.

After identifying the stakeholders, we designed following four studies to find answers for our primary research question covering all the stakeholders:

- **Study 1 :** Online survey with the university students to understand their mobile phone usage behavior

- **Study 2:** In-person interviews with the university students to understand their mobile phone usage behavior

- **Study 3:** Technology reviews of the mobile phone technology including hardware and software

- **Study 4:** Interviews with the Mental health & well-being professionals and experts

2.1 Study 1- Online Survey with the university students [1]

Study Objective: To understand mobile phone usage behaviors and patterns among university students and its impact on their mental health and well-being. Several studies highlight critical behavioral patterns associated with mobile phone usage, including screen time and dependency. Prolonged use is often linked to stress, reduced academic performance, and decreased physical activity due to excessive reliance on phones can escalate stress and social isolation; social media platform usage amplifies comparison and self-esteem issues, which can affect students' mental health (Keles et al., 2020). The survey also explored how they cope with mental health challenges and their help-seeking behavior from their peers, professionals, and technology, as several studies highlight that students rely on peer support, including friends, for informal counseling and shared experiences to manage stress (Rickwood et al., 2007).
Methodology: An online survey was created in Microsoft form and shared with in IIIT students as well

as on social media platform including LinkedIn, Facebook and other online networks of students within India. The online survey particularly suited for this study considering university students being frequent users of mobile phones and digital platforms, making it an intuitive method for collecting data in a medium they are comfortable with (Evans and Mathur, 2018). Online surveys also provide a sense of anonymity, encouraging honesty and reducing social desirability bias (Tourangeau and Yan, 2007). This online survey was complemented with qualitative methods (Study 2: In-person interviews) to understand the situation comprehensively..
Sample Size: 286 (154 IIIT students and 132 students from other universities across India.

2.2 Study 2 In-person interview with university student [2]

Study Objective: To understand and analyze university students' mental health and well-being needs and examine their primary challenges and awareness of available resources through in-person interviews. This study explores their potential acceptance of a mobile and AI-enabled mental health solution. It identifies key motivators and barriers to using AI-based mental health tools, their preferences around personalization, privacy, data control, and discreetness and engagement features that contribute to sustained use. Additionally, identify effectiveness and meaningful outcomes indicators from the user's perspective..
Methodology: In-person interviews, a qualitative research method for in-depth insights allowing researchers to establish rapport and create a safe environment for open and honest discussions (Knox and Burkard, 2009). As it takes place in person, the researchers can use non-verbal cues that provide additional context to verbal responses (Opdenakker, 2006).
Interview Guide Our interview included open-ended, exploratory questions covering areas such as accessibility, personalization, and privacy concerns, as well as desired outcomes and metrics for success. The interview covered the following:

- Introduction and Warm-Up Questions to understand university students' existing mental health and well-being management strategies, their familiarity and experiences with digital mental health and well-being tools and understand participants' views on the potential role of AI and mobile technologies in enhancing mental health sup-

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[1]Online Survey

[2]In-person Interview Questionnaire

port, including any expectations or reservations.

- **Potential Acceptance** including their interest and motivation, desired features, & identifying needs related to customization & personalization.

- **Identifying Barriers to Usage**, including privacy and security concerns, needs relating to data transparency, discreetness and secrecy, and technical accessibility, usability and ease of use, etc.

- **Desired Outcomes and Success Metrics**, including User-centered success metrics ,engagement and satisfaction, and long-term impact and behavioral changes.

- **Closing Thoughts** to gather user-specified features that would make an AI-driven mental health app both effective and trustworthy and gather participants' suggestions for enhancing its relevance and helpfulness.

Sample Size: 21 students from IIIT Hyderabad and few other institutes/colleges around Hyderabad.

2.3 Study 3 Technology Review (Mobile Phones and AI)

Study Objective: To explore and analyze the role of mobile phone technology, including its hardware components (e.g., sensors) and software applications, in tracking and interacting with users' behavioral data. This study investigates how these technological features including mobile phone hardware, built in sensors and software can capture relevant behavioral indicators, assess their accuracy in reflecting mental health states, and evaluate their potential for supporting AI-enabled mobile phone based mental health solutions tailored to individual needs.

Phone Devices: We used two phones' models (one Android phones and one IOS Phone) for conducting the technology review:

- **OnePlus 7, Model No. GM1901** - Majority of university found to be using Android Phone

- **Apple iPhone 13**

2.4 Study 4-Interview with the mental health experts [3]

Study Objective: This research aims to understand essential behavioral indicators for assessing mental health, focusing on patterns like sleep, activity, social interactions, and signs of anxiety, depression, or stress. It will explore how mobile and digital

data— such as social media usage, activity levels, and communication frequency—can contribute to a comprehensive mental health profile. Additionally, the study seeks expert opinions on optimal data collection frequency and preferences for passive versus user-reported data, ensuring minimal intrusiveness while maintaining accuracy. Lastly, it will address ethical considerations, such as privacy and data control measures to build patient trust and uphold ethical standards.

Methodology: In-person interviews with 3 mental health and well-being experts including Counselor in and around Hyderabad..

Interview Guide: The interview focused on gaining insights into essential behavioral indicators for assessing mental health and exploring how digital data can aid in building a comprehensive mental health profile for users. The process included introduction and context setting and covered queries related to Behavioral Indicators for Mental Health Assessment, The potential of Mobile and Digital Data, Data Collection Preferences, Privacy, Security, and Ethical Considerations, and Engagement and Trust-building measures.

3 RESEARCH FINDINGS

Findings from four studies are explained below:

3.1 Findings: Research Study 1 - Online Survey with Students

3.1.1 Compulsive Phone Checking

The survey reveals a solid attachment to mobile phones, especially checking first thing after waking up and during social or academic activities, which points to the potential for phone overuse or addiction. This can disrupt focus and reduce face-to-face social interactions, leading to further dependency on mobile.

3.1.2 Academic Distraction and Need for Balance Usage

Mobile phone usage is a significant distraction during classes, which can undermine students' ability to absorb the material and engage in learning, leading to compromised academic performance and adding further to mental health and well-being. While some students perceive mobile phones as beneficial to their academic performance, most see them as distracting. This implies the need for interventions or strategies to promote balanced usage that minimizes negative im-

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[3]Interview Questionnaire

pacts while leveraging positive aspects, such as accessing learning resources.

3.1.3 High Academic & Personal Pressure

A significant portion of students (60.75%) report feeling overwhelmed by academic or personal pressures frequently or consistently, suggesting mental strain is expected, which could impact their well-being and academic performance.

3.1.4 Concentration Challenges

Most (91.77%) of students find it difficult to focus, with 48.12% reporting that they lose concentration and focus frequently or consistently. This indicates that many students struggle with concentration due to stress or external pressures.

3.1.5 Inadequate Sleep and Disruption

The survey reveals that nearly two-thirds of the students (63.29%) sleep less than the recommended sleep of 7 Hours for young adults. This further contribute to the stress, reduced concentration, and overall health issues. Many students (63.29%) reported occasional or frequent sleep disruptions, which correlated to their reported stress levels, impacting their ability to maintain healthy sleep patterns.

3.1.6 Burden and Sources of Stress, Anxiety, and Depression

The survey result highlights a concerning appearance of mental health issues among university students, with a significant 83% experiencing anxiety or panic at varying levels, while only 19.22% report rarely or never facing these emotions. Stress is especially prevalent, impacting nearly 70% of students, followed by anxiety at 56.7% and low self-esteem at 51.4%. A significant number of students also express feelings of loneliness (47.88%), hopelessness (46.13%), and disconnection (44.66%), indicating that many students struggle with a combination of emotional and mental challenges. 88% of students indicating they often or occasionally feel mentally and emotionally drained, suggests a persistent difficulty in maintaining resilience and overall well-being. About sources of stress, academic pressure was reported by 81%, whereas 57% indicated uncertainty about the future.37% of them blamed bad personal relations as the cause of their stress.

3.1.7 Coping Mechanism and Help Seeking Behavior

The survey data shows a strong inclination towards taking charge of their mental well-being among university students, with 60% of them choosing to manage their health on their own and avoiding seeking out help from professional assistance, and only 6% of students sought help from mental health professionals, due to concerns about stigma and judgment. Instead, the survey data shows that the students rely more on informal coping options, including, seeking support from friends (67%), participating in hobbies (61.82%), and browsing social media (56.73%). Other approaches include ignoring their problems (43.64%), engaging in physical exercise (36.36%), and practicing meditation (22.18%). The nearly even split between those open to seeking help versus those reluctant highlights an opportunity to tackle obstacles to professional support, such as stigma, by encouraging accessible, stigma-free mental health services specifically designed for students.

3.1.8 Comfort Discussing Mental Well-being Issues

This survey shows that merely 26.83% of students feel at ease discussing mental health issues with their families and close friends, while 32.93% do not, it highlights to considerable barriers to openness about mental health within student communities. This hesitation to talk about mental health may stem from belief that family or friends may not comprehend the issues, or elements such as elements such as stigma, the fear of being judged, which are particularly widespread among younger populations. This indicates the necessity for enhancing a peer support system, creating judgment-free environments and introducing mental health education and support system in schools and universities for a better mental health well-being among university students.

3.1.9 Potential of AI enabled Mobile Phone based mental health & well-being solution

64.51% showing interest in AI- driven mobile solutions for mental health and well- being reveals their positive attitude for such solutions or applications. However, only 7% are currently utilizing the available mobile solutions, suggests a huge gap between interest in using the AI driven mobile solutions and its actual utilization. Many research studies has indicated that young adults, including university students, tend to show a high level of openness to AI-driven solutions for mental health because of their perceived

convenience, accessibility, and potential for personalization but it also imply a necessity for targeted awareness and trust-building efforts that tackle students' concerns, such as those related to effectiveness, privacy, and personalization, to improve the adoption and effectiveness of these solutions.

3.1.10 Conclusion

The survey findings highlight significant concerns regarding university students' mental health and well-being, with a high prevalence of compulsive phone checking, academic distractions, and social disconnection tied to mobile phone usage. Students report frequent distractions in academic settings, impacting concentration and leading to compromised academic performance. Additionally, inadequate sleep and pervasive feelings of stress, anxiety, and emotional exhaustion were reported, with academic pressures and uncertainty about the future identified as primary stress sources. While many students are open to using AI-enabled mobile solutions for mental health support, only a small%age currently use such resources, indicating an opportunity for interventions. Despite some students expressing comfort discussing mental health issues with family or friends, a notable%age remain hesitant, citing stigma as a barrier. The survey insights highlight a critical need for an accessible and adequate mental health support system, that address the complex and interconnected issues of stress, emotional fatigue and self-esteem, and offer some accessible mental health and well- being solution which is personal, accessible, can prevent and addresses students' academic, emotional, and social well-being real-time, discreetly, efficiently and effectively for university students.

3.2 Findings: Research Study 2 - In-person Interviews with Students

3.2.1 University Students' Existing Mental Health Strategies

Most participants relied on informal networks like friends and family for mental health support. Many expressed challenges in openly discussing mental health issues due to stigma or lack of understanding. While some students had tried digital mental health tools, such as mood-tracking apps or mindfulness platforms, their engagement was often short-lived due to a lack of personalization and perceived ineffectiveness.

3.2.2 Potential Role of AI and Mobile

Students were optimistic about AI's potential to provide tailored interventions and predictive insights. Many viewed mobile technologies as a convenient platform for daily mental health management. Concerns about data misuse and the inability of AI to fully understand human emotions were frequently mentioned.

"I don't want to share my mental health situation with everyone as I am worried if they make judgment about me, so mostly I engage myself with my mobile phone browsing internet, listening to music, watching video and other material which helps me come out of that state and provide a sense of relief."

3.2.3 Desired Features for Engagement and Personalization

Key Preferences

- Customized UI to suit individual preferences.
- AI-driven personalization that adapts to mood patterns and habits.
- Gamified elements to maintain high engagement.
  Motivators
- Features like rewards, reminders, and real-time feedback were seen as crucial to sustaining usage.

Privacy and Security Concerns

- Strong apprehensions about how sensitive mental health data would be stored and used.
- A clear demand for transparency in data collection and usage policies.

Discreetness

- Many participants highlighted the need for apps to be unobtrusive and provide options for anonymous usage.

Usability Challenges

- Complex navigation and overly technical interfaces were cited as deterrents.

3.2.4 Data Control and Transparency Needs

Students emphasized the importance of having complete control over their data, including options to delete or restrict access. Research confirms that handling sensitive mental health data securely is critical (32). Transparency features, such as detailed reports on how data is used, were considered essential for building trust.

3.2.5 Desired Outcomes and Success Metrics

User-Centered Metrics

- Improved mood stability, reduced anxiety episodes, and better sleep were mentioned as tangible success indicators.
- Metrics like sustained app engagement and high satisfaction rates were seen as proxies for effectiveness.

Long-Term Impact

- Participants valued solutions that could foster positive behavioral changes over time, such as developing healthier coping mechanisms.

3.2.6 Suggestions for Effectiveness and Trustworthiness

Features to be Included

- Real-time support during crises, such as guided breathing exercises or escalation to human counselors.
- Integration with wearable devices for a more comprehensive assessment of behavioral patterns.Trust-Building Measures.

Trust-Building Measures

- Explicit opt-in mechanisms for data sharing and robust encryption protocols.
- AI explain-ability features to demystify how insights and recommendations are generated.

3.2.7 Conclusion

The insights highlight a significant gap in existing mental health apps, particularly in personalization, privacy, and sustained engagement. AI and mobile technologies have the potential to bridge this gap by offering user-centric, adaptive, and trustworthy solutions. However, addressing ethical concerns, ensuring transparency, and delivering measurable outcomes are critical to their success.

3.3 Findings from Research Study 3 - Mobile Phones Technology Review

3.3.1 Hardware Components

Smartphones are equipped with a wide range of hardware, sensors, and software that enable them to monitor a variety of usage behaviors and activities of the user. These can provide insights into user profiles, mental and physical health, and overall well- being.

3.3.2 Sensors

There are multiple sensors are embedded in Smartphones which can help in monitoring various physical and behavioral aspects of the use including Accelerometer that measures movement and orientation, detecting activities like walking, running, or shaking the phone. It can track physical activity levels and identify sedentary behavior or physical exertion. Gyroscope detects angular rotation, improving movement accuracy. It can track physical activities, exercise, or even postures as it's used in gaming and apps. Magnetometer (Compass), provides orientation relative to the Earth's magnetic field. It is helpful in navigation apps but can also give insights into daily movement patterns. GPS track's location data, which can provide information on travel habits, preferred environments, and social behaviors (e.g., visiting parks or gyms). It also can be used for tracking outdoor physical activity. Proximity Sensor detecting when the phone is near the user's face or ear can help monitor screen usage or phone habits (e.g. if the user spends more time on calls). Ambient Light Sensor adjusts the screen brightness based on environmental lighting, but it can also track the lighting conditions in which the phone is used, giving insights into sleep-wake cycles.

Additional sensors include the barometer, which measures atmospheric pressure to calculate altitude and contributes to activity tracking by identifying stair climbing or elevation changes, and the temperature sensor, which tracks external or body temperature in health-focused applications, though its presence is less common. Heart Rate Sensor tracks heart rate and can indicate stress levels. SpO2 Sensor (Oxygen Saturation) It found in some health-focused smartphones, to monitor blood oxygen levels and overall cardiovascular health. Fingerprint Scanner, offers biometric security that can log usage patterns related to device unlocking, providing insights into phone usage frequency

3.3.3 Software and Apps

The smartphone's software is where much of the data processing takes place and includes, Operating System (iOS, Android) that facilitates data collection and analysis, as well as AI/ML algorithms that track and interpret behavior. Health Apps (e.g., Google Fit, Apple Health) integrates sensor data to track physical activity, steps, heart rate, and more. These apps aggregate data over time to provide health reports. Activity Trackers (e.g., Fit-bit, Samsung Health) collects movement and fitness data (steps, calories burned, exercise routines) and can provide insights into physi-

cal health. Voice Assistants (e.g., Siri, Google Assistant) track voice commands and communication habits, possibly analyzing tone and word choice to monitor stress levels or emotional health. Sleep Monitoring Apps (e.g., Sleep Cycle) use accelerometer and microphone data to track sleep patterns, including time spent in different sleep stages, detecting potential sleep disorders like insomnia. Mental Health Apps (e.g., Calm, Head-space) Analyze voice tone, app usage patterns, or even physical behaviors (such as tapping) to assess mental well-being, anxiety, or mood changes and Usage Behavior Apps (e.g., Digital Well- being) tracks phone usage, screen time, app usage frequency, and notifications to analyses user habits and potential signs of addiction, stress, or productivity levels.

3.3.4 Conclusion

Smartphones can track a variety of behavior that contribute to building a user profile and understanding their mental and physical health:

Physical Activity -Sensors like the accelerometer, gyroscope, and GPS track steps, running, cycling, and general movement. This data can be used to assess whether the user meets recommended activity levels for good health.

Sedentary Behavior -Extended periods without movement can be flagged to indicate inactivity, which may suggest poor physical health or risk factors for lifestyle-related diseases.

Sleep Pattern -By monitoring screen time, ambient light, and activity before bed, smartphones can estimate sleep duration and quality, alerting users to potential sleep disorders.

Social Interaction-Monitoring call logs, text message frequency, and time spent on social media apps can give insights into social engagement or isolation, a factor in mental health.

Emotional State and Stress Levels -Using AI algorithms, smartphones can analyze voice patterns, typing speed, or app usage to detect changes in mood or stress. For example, frequent use of mental health apps or certain language cues in text messages may indicate emotional distress.

Dietary Habits -Some apps allow users to log their meals, and smartphone cameras can identify food items, helping track nutritional intake. This data can be used to assess diet quality and its impact on health.

Cognitive Performance -Gaming apps or cognitive training tools can track mental agility, memory, and focus over time. Changes in performance could indicate stress, fatigue, or cognitive decline.

3.4 Findings from Research Study

3.4.1 Most crucial behavioral indicators to assess mental health and well-being

The most crucial behavioral indicators to assess mental health and well-being drawn from the interviews with the three mental health and well- being experts are:

Sleep patterns

- Sleep patterns including quality, duration, and consistency, are primary indicators of mental health well-being.
- Disruptions in sleep (insomnia), irregular sleep schedules, and excessive sleep are indicators of mental health issues such as depression, anxiety, and stress.

Physical activities

- Physical activities have a positive impact on mental health and well-being, especially in reducing depression and anxiety; a reduction in physical activities or lack of motivation to engage in physical activities indicates issues with mental health and well-being.

Social Interactions

- Social interactions serve as protective factors for mental health and frequency and quality. Any reduction in social engagements, withdrawal from social events, or changes in patterns of communication, like withdrawing from communication, are early signs of depression and anxiety.

Observable signs of anxiety, depression, and stress

- Observable signs such as restlessness, mood swings, irritability, or lack of focus, are signals for increased stress and anxiety levels. Close monitoring of daily behavior can help identify such symptoms, which must be addressed.

3.4.2 Use of digital footprints to assess mental health

In the current age of digital society, where mobile phones and the internet have become integral parts of our daily lives, digital engagement behaviors and patterns, including usage of social media, browsing patterns, and communication frequency, are emerging as valuable indicators of mental health and well-being.

3.4.3 Conclusion

The use of digital footprints in mental health assessment offers promising benefits, including early detection, personalized care, and enhanced understanding

of patient experiences. However, it also presents significant challenges related to privacy, ethical use, and the risk of misinterpretation.

3.5 Conclusion from the Four Studies

The findings from the studies collectively underscore the immense potential of employing a human-centered approach to develop mobile and AI-enabled just-in-time mental health solutions for university students in India. The studies reveals that the university students in India face significant mental health challenges, including stress, anxiety, emotional exhaustion, and low self-esteem, often rooted in academic pressure, uncertainty about the future, and personal relationships. Compulsive mobile phone usage and inadequate sleep patterns adds to the same. The limited willingness to seek professional help due to stigma highlights the need for discreet and stigma-free solutions. The study also revealed that even though the compulsive use of mobile phone is contributing to these challenges but the hardware, software and various sensors built into the smart phones, captures various factors that are similar to those used by the mental health professional to assess and mental health and well-being conditions and also offer therapy.

AI-enabled smartphones offers potential to deliver personalized, adaptive, and real-time support metal health assessment and support by capturing behavioral and environmental data, enabled through its advance hardware and sensors. Students express optimism about mobile technologies and AI's potential to provide just-in-time mental-health support due to stigma highlights the need for discreet and stigma-free solutions.

A human-centered design of mobile and AI-enabled just-in-time mental health solutions has the potential to empower university students to manage their well-being effectively. By leveraging smartphones' capabilities, AI and applying human-centered approach we suggest a human-centered framework (Refer figure 1) and "MindMate" (Refer figure 2), A Mobile Phone and AI-Enabled Just-in-Time Mental Health & Well-being Solution that can be made available on mobile phones and tailored to the unique needs and concerns related to the mental health and well-being of Indian university students. This framework can address privacy, personalization, and stigma, such solutions can deliver adaptive, empathetic, and accessible mental health and well-being support.

4 SUGGESTED FRAMEWORK & SOLUTION

Insights from the four studies led us to the following framework (Refer to Figure 1) that emphasizes a holistic, user-centered approach to creating an AI- enabled just-in-time (JIT) mental health solution that is available on mobile phones and tailored to the unique needs and concerns of Indian university students. Integrating AI's capabilities this framework offer effective, personalized, engaging and ethical support for mental well-being.

4.1 Core Pillars of the Framework

4.1.1 Personalization

- Using AI, create dynamic user profiles based on behavioural data (e.g., sleep patterns, physical activity, social interactions).)
- Offer adaptive content delivery tailored to the user's mental health status (e.g., music, video, content recommendations, suggest mindfulness exercises, motivational messages, chat/ conversations with AI agent as Virtual buddy).

4.1.2 Apply Privacy & Ethical Use of User Data

Must implement a transparent data governance policy. Use secure data encryption and anonymization. Adhere to consent-driven data collection practices and local data protection regulations.

4.1.3 Offer Engagement and Gamification

Integrate gamification techniques to encourage motivated engagements and sustained use. Offer rewards to motivate users to encourage healthy behaviors like following regular sleep, engaging in physical activity, and with mental health resources.

4.2 Key Features

4.2.1 Real-Time Monitoring and Feedback

Using data inputs from the smartphone sensors monitor critical indicators like:

- **Sleep:** Screen activity, ambient light levels.
- **Physical Activity**: Steps, movement patterns.
- **Social Interaction:** Communication frequency and time spent on apps.

Framework for Mobile Phone and AI-Enabled Just-in-Time Mental Health & Wellbeing Solution

DESIGN THINKING AND HUMAN(USER)-CENTRED APPROACH

| User Research (Empathize) Understanding Users and Context | Define Articulating the Problem Statement | Ideate Brainstorming Solutions | Prototype Developing the Solution | Test/Validate Evaluating and Refining the Solution |

CORE PILLERS

Personalisation
Leverage AI to create dynamic user profiles based on behavioral data (e.g., sleep patterns, physical activity, social interactions)
Adaptive content delivery tailored to the user's mental health status (e.g., mindfulness exercises, motivational messages).

Privacy and Ethical Use
Implement a transparent data governance policy.
Use secure data encryption and anonymization.
Adhere to consent-driven data collection practices and local data protection regulations.

Engagement and Gamification
Integrate gamification techniques to encourage sustained use.
Offer rewards or streaks for healthy behaviors like regular sleep, physical activity, and engaging with mental health resources.

KEY FEATURES

Real-Time Monitoring and Feedback
Use smartphone sensors and data inputs to monitor key indicators:
Sleep: Screen activity, ambient light levels., **Physical Activity:** Steps, movement patterns and **Social Interaction:** Communication frequency and time spent on apps.

AI-Driven Insights
Analyze digital footprints (e.g., browsing behavior, text sentiment analysis) to identify early signs of mental health issues like depression or anxiety.
Predict and provide recommendations for potential risks using predictive analytics and therapeutic content e.g music, videos, games, activities etc.

Behavioral Nudges
Send actionable notifications based on tracked patterns (e.g., reminders to move after prolonged inactivity, relaxation techniques during stressful periods).

Self-Help Tools
Reccommendation about therapeutic content such as music, videos, games, Guided meditation, cognitive behavioral therapy (CBT) exercises, and journaling features.

Human Support Integration
Link users to university counselors or helplines when critical thresholds are met.
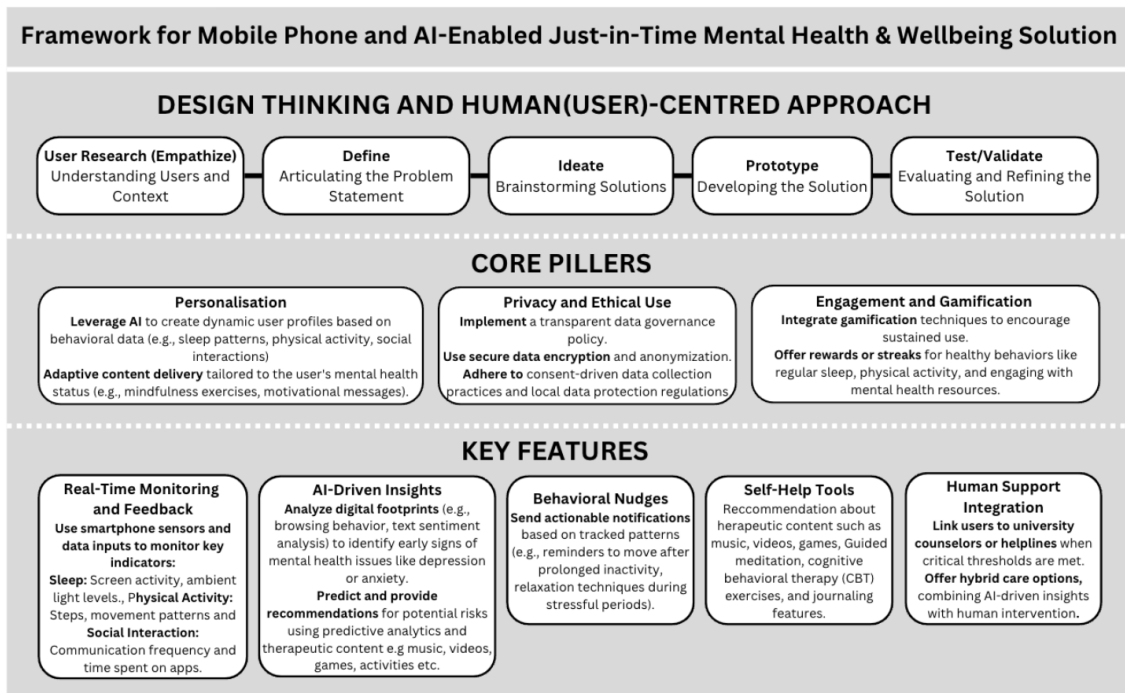**Offer hybrid care options,** combining AI-driven insights with human intervention.

Figure 1: Framework for the mobile phone and AI-Enabled JIT Mental Health & Wellbeing Solution

4.2.2 AI-Driven Insights

- Analyse digital footprints (browsing behaviour, text sentiment analysis) to detect early signs of mental health issues like depression/ anxiety.

- Predict and provide recommendations for potential risks using predictive analytics.

4.2.3 Behavioural Nudges

Send actionable notifications based on tracked patterns (e.g., reminders to move after prolonged inactivity, relaxation techniques during stressful periods).

4.2.4 Therapeutic Recommendations

Offers therapeutic recommendations such as music, videos, games, or other content that can serve as support in preventing or offering some relief when any stress, depression, or anxiety is tracked in the users.

4.2.5 Self-Help Tools

Offers Guided meditation, cognitive behavioral therapy (CBT) exercises, and journaling features

4.2.6 Human Support Integration

- If needed, it links users to university counsellors or helplines when critical thresholds are met.

4.3 "MindMate", A Mobile and AI-Enabled Just-in-Time Mental Health & Wellbeing Solution

Considering the suggested framework above (Refer to Figure 2), "MindMate" is conceptualized to empower university students by fostering emotional resilience, mental clarity, and personal growth through a seamless, AI-driven mobile experience. It transforms the everyday smartphone into a supportive "AI-enabled virtual buddy," blending advanced AI with behavioral insights, such as Sentiment Analysis and Social Support Theory to dynamically respond to users' emotional states and support mental well- being.
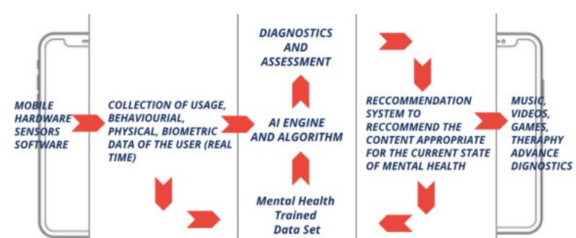

Figure 2: "MindMate" Concept

"MindMate" integrates AI with mobile hardware, sensors, and software to subtly track user behaviours, activities, and biometric data, predicting moments of

stress, anxiety, or low mood. During such moments, it intuitively suggests curated content, whether music, videos, reading material, or games contextually (e.g., recommending some music tracks, etc., when they browse music- a recommendation not forced) that helps uplift and soothe the user. This tailored support respects each user's autonomy and emotional privacy, gently reinforcing positive mental health habits without overtly identifying triggers.

"MindMate" also offers a pro-active mode where Virtual Buddy initiates Chat with the users when it finds some abnormality in the user behaviour directing towards some stress, depression, anxiety etc. Providing just-in-time help to overcome the same.

In a context where mental health support must be personal, empathetic, and culturally sensitive, "MindMate" aspires to redefine student well-being by becoming a compassionate ally. By merging technology with mindful, unobtrusive engagement, "MindMate" aims to empower students to naturally cultivate resilience, self-care, and balance in their everyday lives.

4.3.1 Core Components of the " MindMate" [4]

Human Centered Features	AI Integration	Ethical Consideration
Personalization: It should offer AI-driven recommendations based on individual behavior and cultural context.	**Behavior Tracking:** Use sensors to monitor sleep, physical activity, and digital engagement patterns.	**Privacy:** It must incorporate rigorous encryption and transparent data usage policies.
Localization: Considering language and cultural diversity within India, it should support for multiple Indian languages and culturally relevant content.	**Adaptive Algorithms:** Offer real-time analysis of behavioral patterns to provide tailored & just-in-time interventions	**Data Control:** Allow users to decide what data is collected and how it is shared.
Gamification: It should incorporate elements like goal setting and rewards that are goal oriented, interactive, engaging and motivate the users.	**Predictive Analytics:** Provide early identification of stress, anxiety, or depression trends.	**Inclusivity:** Ensure the app is accessible to students with disabilities or those in low-connectivity regions.
Discretion, Design discreet interfaces for private use, ensuring anonymity.	**Conversational AI:** Offer Chatbots as Virtual Buddy for immediate emotional support and connection to counsellors if needed.	

Figure 3: Core Components of the "MindMate"
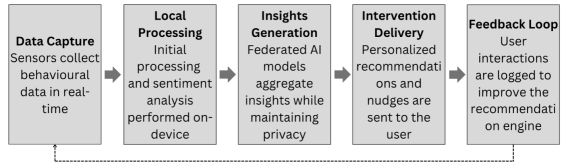
4.3.2 "MindMate" Workflow [5]

Figure 4: "MindMate" Workflow
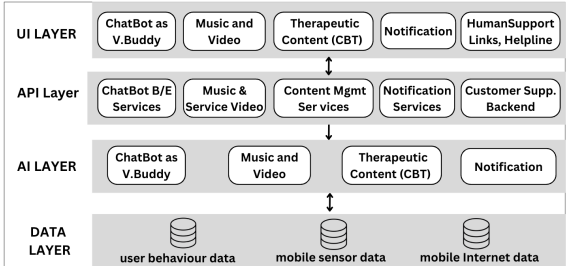
4.3.3 "MindMate" Architecture [6]

Figure 5: Core Components of the "MindMate"

5 CONCLUSIONS

This framework emphasises a holistic, user-centred approach to creating an AI-enabled just-in-time (JIT) mental health solution that is aligned to the unique needs and concerns of Indian university students. By integrating Design Thinking and Human-centered principles with AI's capabilities, Mind-Mate, can provide effective, personalized, and ethical support for mental well- being leading to Improved Mental Health Outcomes- Early detection of mental health issues, Better engagement in health-promoting behaviours; Enhanced Academic Performance-Improved sleep and reduced stress levels; Aggregated insights for universities to design targeted mental health interventions.

6 FUTURE WORK

Based on our proposed framework and the concept solution, we plan to build a prototype of "MindMate," an AI-enabled virtual buddy available on mobile to support users in their mental health & well-being. This prototype will then be tested for its usability and functionality by inviting the university students. Using a convenience sampling approach, we plan to invite around 20 students between 18 and 26 years. They will be asked to use this product for 4 to 5 weeks, and then will be interviewed about their experiences, mental health well-being status, and suggestions they have to make this solution better and more impactful.

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[4]Core Components of the " MindMate"
[5]"MindMate" Workflow

[6]"MindMate" Architecture

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REFERENCES

(2020). Who report 2020. World Health Organization.

Ahmed, A., Ali, N., Aziz, S., Abd Alrazaq, A. A., Hassan, A., Khalifa, M., and Househ, M. (2021). A review of mobile chatbot apps for anxiety and depression and their self-care features. *Computer Methods and Programs in Biomedicine Update*, 1:100012.

Carbonell, X., Chamarro, A., Griffiths, M., Oberst, U., Cladellas, R., and Talarn, A. (2012). Problematic use of the internet and mobile phones in spanish adolescents and young people. *Annals of Psychology*, 28(3):789–796.

Chandrashekar, P. (2018). Do mental health mobile apps work: evidence and recommendations for designing high-efficacy mental health mobile apps. *Mhealth*, 4.

Danneel, S., Maes, M., Vanhalst, J., Bijttebier, P., and Goossens, L. (2018). Developmental change in loneliness and attitudes toward aloneness in adolescence. *Journal of Youth and Adolescence*, 47:148–161.

Dutta, G., Rajendran, N., Kumar, T., Varthya, S. B., and Rajendran, V. (2023). Prevalence of depression among undergraduate medical students in india: A systemic review and meta-analysis. *Cureus*, 15(1).

Eisenberg, D., Downs, M. F., Golberstein, E., and Zivin, K. (2009). Stigma and help seeking for mental health among college students. *Medical Care Research and Review*, 66(5):522–541.

Evans, J. R. and Mathur, A. (2018). The value of online surveys: A look back and a look ahead. *Internet Research*, 28(4):854–887.

Firth, J., Torous, J., Nicholas, J., Carney, R., Pratap, A., Rosenbaum, S., and Sarris, J. (2017). The efficacy of smartphone-based mental health interventions for depressive symptoms: a meta-analysis of randomized controlled trials. *World Psychiatry*, 16(3):287–298.

Fitzpatrick, K. K., Darcy, A., and Vierhile, M. (2017). Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (woebot): a randomized controlled trial. *JMIR Mental Health*, 4(2):e7785.

Griffiths, M. D. and Kuss, D. (2017). Adolescent social media addiction (revisited). *Education and Health*, 35(3):49–52.

Hunt, J. and Eisenberg, D. (2010). Mental health problems and help-seeking behavior among college students. *Journal of Adolescent Health*, 46(1):3–10.

IDEO (2015). *The Field Guide to Human-Centered Design*. IDEO.org.

IMRB (2016). *Report by Mobile Marketing Association, in collaboration with Kantar*.

Jacobson, N. C., . F. B. (2022). Digital phenotyping of generalized anxiety disorder: using artificial intelligence to accurately predict symptom severity using wearable sensors in daily life. *Translational Psychiatry, 12(1), 336*.

Keles, B., McCrae, N., and Grealish, A. (2020). A systematic review: the influence of social media on depression, anxiety and psychological distress in adolescents. *International Journal of Adolescence and Youth*, 25(1):79–93.

Kemp, S. (2023). Digital 23: India. Dataportal.

Knox, S. and Burkard, A. W. (2009). Qualitative research interviews. *Psychotherapy Research*, 19(4–5):566–575.

Opdenakker, R. J. G. (2006). Advantages and disadvantages of four interview techniques in qualitative research. *Forum Qualitative Sozialforschung= Forum: Qualitative Social Research*, 7(4):art–11.

Reddy, K. J., Menon, K. R., and Thattil, A. (2018). Academic stress and its sources among university students. *Biomedical and Pharmacology Journal*, 11(1):531–537.

Richardson, T., Elliott, P., and Roberts, R. (2017). Relationship between loneliness and mental health in students. *Journal of Public Mental Health*, 16(2):48–54.

Rickwood, D. J., Deane, F. P., and Wilson, C. J. (2007). When and how do young people seek professional help for mental health problems? *Medical Journal of Australia*, 187(S7):S35–S39.

Tarafdar, M., Pullins, E. B., and Ragu-Nathan, T. S. (2015). Technostress: negative effect on performance and possible mitigations. *Information Systems Journal*, 25(2):103–132.

Torous, J. and Roberts, L. W. (2018). Assessment of risk associated with digital and smartphone health research: A new challenge for institutional review boards. *Journal of Technology in Behavioral Science*, 3:165–169.

Torous, J., Wisniewski, H., Liu, G., and Keshavan, M. (2018). Mental health mobile phone app usage, concerns, and benefits among psychiatric outpatients: comparative survey study. *JMIR Mental Health*, 5(4):e11715.

Tourangeau, R. and Yan, T. (2007). Sensitive questions in surveys. *Psychological Bulletin*, 133(5):859.

Venkatesh, B. T., Andrews, T., Mayya, S. S., Singh, M. M., and Parsekar, S. S. (2015). Perception of stigma toward mental illness in south india. *Journal of Family Medicine and Primary Care*, 4(3):449–453.