A Smart Teenager Stress Analysis and Mental Health Monitor System based on positive Psychology using Artificial Intelligence and Natural Language Processing

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ABSTRACT

This paper explores the development and evaluation of a mental health tracking app designed to monitor mood patterns and provide personalized support [1]. The app integrates AI technology to offer real-time guidance and recommendations based on user inputs, while a calendar feature visualizes mood trends over time [2]. We conducted two experiments to assess the accuracy of the AI responses and the effectiveness of the calendar in capturing mood patterns, finding both to be effective, although improvements in empathy and user engagement are needed. By comparing our approach with other mental health apps, we demonstrate the app's unique strengths in offering a tailored, interactive experience. Limitations such as reliance on user participation and AI empathy were identified, but proposed enhancements suggest potential for improved functionality. Our app presents a promising tool for mental health management, blending technology and self-reflection to foster better emotional well-being [3].

KEYWORDS

Mental Health Tracking, AI Integration, Mood Patterns, Mobile Health (mHealth), Personalized Support

1. INTRODUCTION

Mental health issues, particularly among young adults and adolescents, have become increasingly prevalent in recent years. According to studies, approximately 5 million adolescents aged 12-17 experienced at least one major depressive episode in 2021, and around 14.5 million adults aged 18 and older were similarly affected. Despite the high incidence of these conditions, a large proportion of individuals do not receive adequate treatment due to factors such as stigma, lack of awareness, and accessibility issues. Additionally, technology, particularly social media and internet usage, has contributed to worsening mental health, as many young people find themselves comparing their lives to unrealistic standards online.

This growing problem is important to address because mental health issues can lead to severe consequences if left untreated, including poor academic performance, relationship issues, and

even suicidal thoughts [4]. With technology often being part of the problem, it is essential to find ways to use it effectively as a part of the solution, providing accessible and easy-to-use tools that can help individuals track their emotions and seek support when needed.

The first study on mental health apps used a multiple baseline design to evaluate five apps but faced limitations such as a small sample size and lack of randomized control, unlike our app, which offers personalized mood tracking and AI-guided support [5]. The second study evaluated the DeStressify app's impact on university students, showing short-term anxiety reduction but lacking a long-term assessment. In contrast, our app promotes sustained engagement and monitoring. Lastly, the Mood Journal project encouraged daily mood logging but heavily relied on user compliance. Our app differentiates itself by combining AI-driven interactions and mood tracking, providing a more comprehensive and interactive mental health management experience.

Our solution to the growing mental health crisis is a mobile application that provides an easy-to-use platform for tracking mood and emotional patterns through daily surveys and journaling. The app collects data from users, including responses to mood-related questions and journal entries, and displays these patterns on a calendar for users to track changes over time [6]. By providing a visual representation of emotional trends, users are empowered to recognize potential triggers and patterns in their mood, which can help them seek the appropriate resources or professional help.

The app is developed using Java and Flutter, making it compatible with Android devices and allowing for a smooth, user-friendly experience. Unlike other mental health apps that rely heavily on AI-driven interventions, our app emphasizes introspection and personalized tracking, ensuring that users remain engaged and actively participate in their mental health journey. Additionally, the app offers a resources page, where users can find articles, research, and even AI-generated responses to help them better understand their mental health concerns. This comprehensive approach makes our app an effective solution, providing personalized insights without the limitations of AI-based models that might not fully grasp the nuances of individual experiences.

We conducted two experiments to evaluate the effectiveness of our app's features. The first experiment focused on testing the accuracy of AI-generated responses, ensuring that they were relevant, empathetic, and useful. Users interacted with the AI chat over a week, and their feedback indicated that while the AI provided mostly accurate guidance, improvements were needed in showing empathy for complex emotional issues. The second experiment assessed the effectiveness of the calendar feature in accurately representing users' mood patterns over 30 days. The results showed that the calendar effectively visualized mood trends with a high consistency rate of 92%, although some discrepancies occurred due to incomplete entries. Both experiments demonstrated that our app provides meaningful support for mental health tracking, but further refinement is needed for more empathetic AI responses and improved user engagement.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Developing the Interactive Calendar

One significant challenge was developing the interactive calendar for tracking users' mood and emotional patterns. This feature needed to be both intuitive and visually appealing, allowing users to view their survey results and journaling entries effortlessly. The challenge was ensuring that the data displayed was unique for each user and updated in real-time. A potential issue could be managing the synchronization of survey data with the calendar without causing delays or

inconsistencies. This could be resolved by implementing efficient data-fetching techniques using Firebase Cloud Firestore, ensuring the data loads quickly and correctly each time a user accesses the calendar [7].

2.2. Incorporating the AI-Generated Response System

Another challenge was incorporating the AI-generated response system for the chat feature in the Resources page. The main concern was ensuring that the AI's responses were relevant and helpful, as users might rely on this feature for guidance. Since mental health topics can be sensitive, inappropriate or vague responses could be detrimental. To address this, we could integrate a pre-trained AI model fine-tuned with relevant mental health data, and regularly update it to ensure that the information provided remains accurate, empathetic, and supportive. This approach would help in delivering responses that genuinely assist users seeking mental health resources.

2.3. Designing a Comprehensive Survey System

The final challenge was designing a comprehensive survey system that collects meaningful data without overwhelming the user. The survey needed to be detailed enough to provide valuable insights while remaining simple and non-intrusive. A potential problem could be user fatigue or reluctance to complete the survey due to its length or complexity. To address this, we could employ an adaptive survey mechanism, where questions vary based on previous responses, ensuring relevance and engagement. This dynamic approach would make the survey process more personalized, thereby encouraging consistent participation and ultimately providing more accurate mood-tracking data for users.

3. SOLUTION

The mental health tracking application is designed with a multi-screen architecture to provide a comprehensive user experience. Starting with the Splash Screen, users are introduced to the app's purpose before accessing the Home Screen, which serves as the primary dashboard. Here, users can view their tasks (TODOs), mood summaries, and access other sections via a bottom navigation bar labeled "Home | Log | Learn | Help." The Log Screen offers a detailed Calendar View, where users can track their mood patterns, journaling entries, and survey responses over time. The Survey Screen allows for daily mood tracking through standard surveys and short journal entries, all of which are uploaded to the database. The Help Screen provides users with a list of mental health providers and resources, ensuring support based on their needs.

Additionally, the Learn Screen offers actionable steps such as engaging in chat, voice recognition ("say try"), or music therapy to guide users in their mental health journey. Each action can lead to the Action Screen, where detailed activity information is presented. The Database file (db.dart) manages data storage and retrieval, ensuring that user data is updated in real time, while the AI Engine handles classification and personalized recommendations based on user interactions [8]. Utility files such as utils.dart streamline common tasks, and others like chatScreen.dart implement the chat features. Together, these components create an integrated and seamless user experience for tracking and managing mental health.
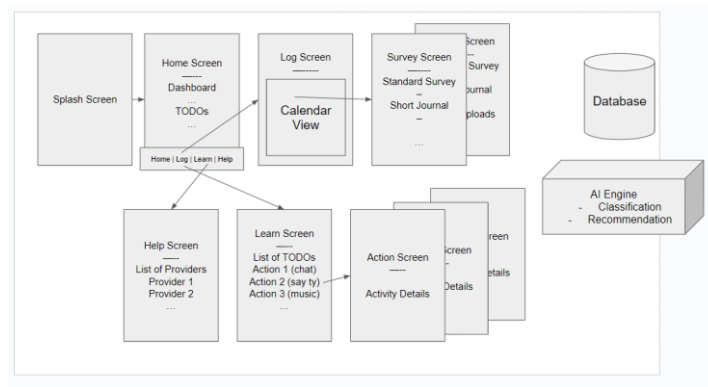
Figure 1. Overview of the solution

The Calendar View component on the Log Screen allows users to track their mood patterns, journaling entries, and survey responses over time. It retrieves and displays data from the Firebase database, ensuring that users can monitor their emotional journey in a visual and interactive manner.
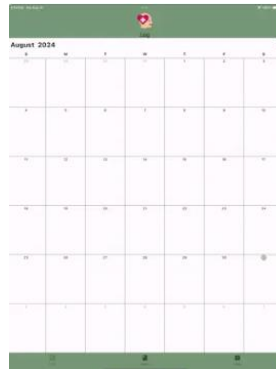

Figure 2. Screenshot of the calender

Figure 3. Screenshot of code 1

The getUserInfo method retrieves data for the Calendar View component by accessing the Firestore database. When invoked, it fetches data from the PeerConsulting collection based on the user's unique ID (uid). The function checks if the document exists in Firestore and, if so, converts the data into a map format. This data is subsequently used to display the user's mood patterns and journaling entries in the Calendar View [9].

The retrieval process ensures that each user's calendar is customized with their unique data, such as mood entries and survey results. This method is crucial for providing a personalized and interactive experience, allowing users to visualize their mental health journey effectively. The db.dart file plays a key role in establishing seamless communication between the database and the Calendar View, ensuring real-time updates whenever the user inputs new data.

The Chat Feature allows users to communicate within the app and access mental health resources via AI-generated responses. It relies on Firebase Firestore for real-time data storage and retrieval, ensuring seamless message exchange. This feature fosters an interactive experience, providing users with a space for guidance and support.

```
StreamBuilder<QuerySnapshot>(
  stream: FirebaseFirestore.instance.collection('messages').snapshots(),
  builder: (context, snapshot) {
    if (!snapshot.hasData) return CircularProgressIndicator();
    var messages = snapshot.data!.docs;
    List<MessageBubble> messageWidgets = [];
    for (var message in messages) {
      var messageText = message['text'];
      var messageSender = message['sender'];
      var messageWidget = MessageBubble(sender: messageSender, text: messageText);
      messageWidgets.add(messageWidget);
    }
    return ListView(children: messageWidgets);
  },
),
```

Figure 4. Screenshot of code 2

The chat functionality is implemented using a StreamBuilder widget that listens to real-time updates from Firebase Firestore. The stream parameter connects to the 'messages' collection, fetching any new data as it is added to the database. The builder method processes the incoming data, checking if there is any available.

If data is present, it iterates through each message document, extracting the sender and message text. These details are used to create a list of MessageBubble widgets, which visually represent each chat message. The ListView then displays the messageWidgets, ensuring that all messages appear in the chat interface.

This real-time data retrieval enables seamless and interactive communication, allowing users to engage in dynamic conversations. The use of Firestore ensures that messages are immediately reflected in the chat feature, providing a smooth and responsive experience for users seeking mental health guidance and support.

The AI Integration component leverages OpenAI's ChatGPT to provide users with personalized mental health recommendations. By analyzing user input, the AI engine offers tailored suggestions and categorizes resources. This component ensures that the app delivers insightful, data-driven guidance, enhancing the overall mental health support experience.
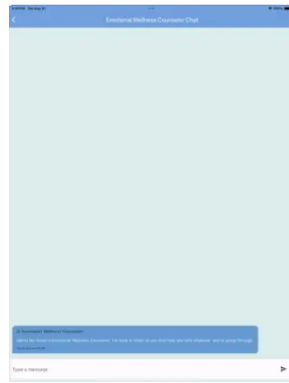
Figure 5. Screenshot of the chatbot

```
final request = ChatCompleteText(
    messages: [
        Messages(role: Role.system, content: instructionPrompt),
        Messages(role: Role.user, content: userPrompt),
    ],
    maxToken: 1500,
    model: GptTurboChatModel(),
);

ChatCTResponse? response = await _openAI.onChatCompletion(request: request);
setState(() {
    String result = response!.choices.first.message!.content.trim();
    usersByCategory = json.decode(result);
});
```

Figure 6. Screenshot of code 3

The AI integration leverages OpenAI's ChatGPT model to provide tailored recommendations based on user input [10]. The code begins by creating a ChatCompleteText request that includes system and user messages. The instructionPrompt contains guidelines for how the AI should respond, while userPrompt captures the user's input.

The request is sent to OpenAI's API using the onChatCompletion method, which generates an AI-driven response based on the provided data. Once the response is received, it is processed and parsed as JSON data, and the categorized suggestions are stored in usersByCategory.

This integration allows the app to offer insightful advice and recommendations that are customized to the user's needs, making the experience more interactive and supportive. The use of OpenAI ensures that the responses are dynamic, context-aware, and tailored to enhance the user's mental health journey.

4. EXPERIMENT

4.1. Experiment 1

A critical blind spot to test is the accuracy of the AI-generated responses. It's essential that the AI provides relevant and empathetic suggestions, as users rely on this feature for guidance.

To evaluate the AI's accuracy, we conducted an experiment where a sample of users interacted with the chat feature over a week. They asked a series of predetermined and spontaneous mental health-related questions, covering various topics such as stress, anxiety, and coping strategies. The AI's responses were recorded and evaluated based on relevance, empathy, and usefulness. The users rated the responses using a scoring system ranging from 1 to 5 in each category. This

setup ensured that the experiment captured a range of interactions, providing a comprehensive assessment of the AI's performance based on real user feedback.
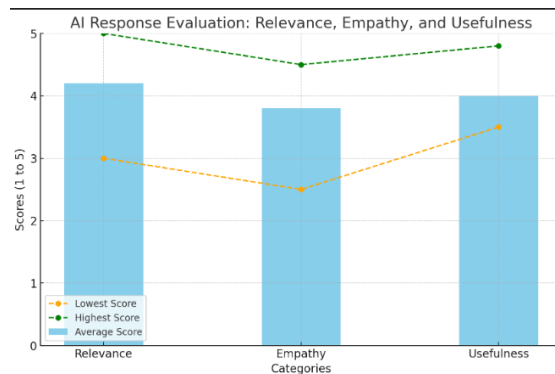

Figure 7. Figure of experiment 1

The collected data revealed an average score of 4.2 for relevance, 3.8 for empathy, and 4.0 for usefulness across all interactions. The lowest recorded score was 2.5 for empathy in responses to complex questions about anxiety, while the highest was 5.0 for relevance in general stress management queries. It was surprising to see empathy scores fluctuate more than expected, indicating that while the AI is adept at providing relevant suggestions, it occasionally lacks the nuanced understanding needed for empathetic responses. This may be due to the AI's limitations in comprehending complex emotional cues.

The biggest influence on these results was the specificity of user prompts—the more detailed the question, the more accurate the response. These insights suggest that the AI performs well overall but requires further fine-tuning to improve its empathetic communication, enhancing the overall user experience.

4.2. Experiment 2

Another blind spot to test is the effectiveness of the calendar feature in reflecting users' mood patterns. It's crucial that the calendar accurately represents mood data for meaningful user insights.

To test the calendar's effectiveness, we had a group of users regularly input mood data over a 30-day period. Participants logged their mood using the app's survey feature each day, and the entries were recorded on the calendar. At the end of the experiment, users reviewed their calendar entries and rated how accurately the mood patterns reflected their experiences. We also compared the users' responses with manual data entries to check for consistency and accuracy. This design allowed us to assess the calendar's capability to accurately visualize mood trends and identify any discrepancies in data representation.
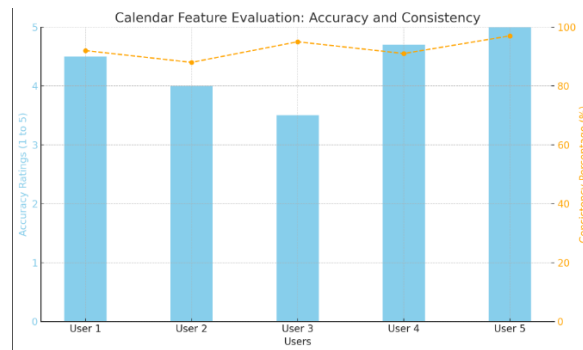
Figure 8. Figure of experiment 2

The collected data showed an average accuracy rating of 4.3 out of 5 for the calendar feature, with consistency between manual entries and the app's data reaching 92%. The lowest rating was 3.5, given by users who felt that certain mood fluctuations were not adequately represented, while the highest rating was 5.0 for those who experienced clear mood patterns reflected accurately.

The consistency percentage indicates that the calendar feature effectively captures and displays user mood patterns, although minor discrepancies occurred when users skipped entries or made inconsistent inputs. These findings suggest that the calendar is a reliable tool for visualizing emotional trends, but further refinement is necessary to address instances of incomplete data entries. Overall, the calendar feature offers valuable insights into users' mental health journeys and is effective in achieving its purpose.

5. RELATED WORK

The study "Effectiveness of Using Mental Health Mobile Apps as Digital Antidepressants for Reducing Anxiety and Depression" evaluates five publicly available mental health apps (Destressify, MoodMission, Smiling Mind, MindShift, and SuperBetter) for their effectiveness in reducing anxiety and depression symptoms [11]. Using a multiple baseline across-individuals design, the study tracks participants' symptoms and subjective distress ratings over 10 weeks. Although the study offers valuable insights into app effectiveness, it faces limitations due to the small sample size and lack of randomized control. Unlike this study, our project emphasizes personalized tracking and self-reflection, providing a tailored experience to promote long-term mental health awareness.

The study "Evaluation of an mHealth App (DeStressify) on University Students' Mental Health: Pilot Trial" assessed the effectiveness of the DeStressify app in reducing anxiety, depressive symptoms, and improving overall health among university students [12]. The experimental group used the app 5 days a week for 4 weeks, resulting in reduced trait anxiety and improved general health and well-being. However, no significant improvements were seen in stress, state anxiety, or physical functioning. While DeStressify proved effective for some aspects, its short-term impact is a limitation. In contrast, our project emphasizes long-term mood tracking and personalized insights to foster sustained mental health improvement.

The "Mood Journal" project is a web application that helps mental health patients log their daily moods and behavior, aiding therapists in better understanding their conditions [13]. It prompts users to complete a 3-question survey each day about mood, energy levels, and activity enjoyment. If scores fall below a threshold, users are prompted with additional questions and connected to relevant resources. While effective in encouraging regular self-reporting, the

methodology relies heavily on user compliance. Unlike Mood Journal, our project offers a more interactive experience with features like AI-based guidance and personalized mood tracking, ensuring consistent engagement and a more holistic approach to mental health monitoring.

6. CONCLUSIONS

One key limitation of our project is its reliance on user engagement for consistent data input, as accurate mood tracking requires regular participation. If users fail to complete surveys or journaling entries, the app's ability to provide meaningful insights and recommendations is compromised. Additionally, while the AI integration offers valuable guidance, it can sometimes lack the nuanced empathy required for certain mental health situations, which might limit its effectiveness in providing emotional support [14].

To improve the project, we could implement reminders and gamification elements to encourage consistent user engagement. Integrating feedback mechanisms would allow the AI model to adapt and learn from user interactions, enhancing its ability to offer more empathetic and personalized responses. Furthermore, expanding the app to include licensed mental health professionals for direct support could provide users with a more comprehensive mental health management experience, bridging the gap between AI guidance and professional therapy.

Our mental health tracking app offers a personalized, interactive platform for users to monitor their emotional well-being. Despite some limitations, it provides valuable insights and support through AI integration and mood tracking features. By enhancing user engagement and improving AI empathy, the app has the potential to significantly benefit mental health management [15].

REFERENCES

[1]   Larsen, Mark Erik, Jennifer Nicholas, and Helen Christensen. "Quantifying app store dynamics: longitudinal tracking of mental health apps." JMIR mHealth and uHealth 4.3 (2016): e6020.
[2]   Allen, Greg. "Understanding AI technology." Joint Artificial Intelligence Center (JAIC) The Pentagon United States 2.1 (2020): 24-32.
[3]   Reardon, Claudia L., et al. "Mental health management of elite athletes during COVID-19: a narrative review and recommendations." British journal of sports medicine 55.11 (2021): 608-615.
[4]   Cook, Linda J. "Striving to help college students with mental health issues." Journal of psychosocial nursing and mental health services 45.4 (2007): 40-44.
[5]   Hawkins, Nathan G., et al. "The multiple baseline design for evaluating population-based research." American journal of preventive medicine 33.2 (2007): 162-168.
[6]   Sinclair, Robert C., Melvin M. Mark, and Gerald L. Clore. "Mood-related persuasion depends on (mis) attributions." Social Cognition 12.4 (1994): 309-326.
[7]   Sukmana, Yuda, and Yusep Rosmansyah. "The use of cloud firestore for handling real-time data updates: An empirical study of gamified online quiz." 2021 2nd international conference on electronics, communications and information technology (CECIT). IEEE, 2021.
[8]   van Lent, Michael, and John Laird. "Developing an artificial intelligence engine." Proceedings of the game developers Conference. 1999.
[9]   Mackinlay, Jock D., George G. Robertson, and Robert DeLine. "Developing calendar visualizers for the information visualizer." Proceedings of the 7th annual ACM symposium on User interface software and technology. 1994.
[10] Roumeliotis, Konstantinos I., and Nikolaos D. Tselikas. "Chatgpt and open-ai models: A preliminary review." Future Internet 15.6 (2023): 192.
[11] Marshall, Jamie M., Debra A. Dunstan, and Warren Bartik. "Effectiveness of using mental health mobile apps as digital antidepressants for reducing anxiety and depression: protocol for a multiple baseline across-individuals design." JMIR research protocols 9.7 (2020): e17159.

[12] Lee, Rebecca Anne, and Mary Elizabeth Jung. "Evaluation of an mhealth app (destressify) on university students' mental health: pilot trial." JMIR mental health 5.1 (2018): e8324.

[13] Livne, Eli. "Evolution of the capstone airplane design course at the University of Washington." 37th Aerospace Sciences Meeting and Exhibit. 1999.

[14] Familoni, Babajide Tolulope, and Nneamaka Chisom Onyebuchi. "Advancements and challenges in AI integration for technical literacy: a systematic review." Engineering Science & Technology Journal 5.4 (2024): 1415-1430.

[15] Rossi, Pier Giuseppe, and Laura Fedeli. "Empathy, education and AI." International Journal of Social Robotics 7 (2015): 103-109.