

Enhancing Adherence and Completion Rates Through Gamification and Micro AI Interventions in Cognitive Behavioral Therapy

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Abstract— In the contemporary digital era, mental health awareness has improved, yet challenges remain in therapy adherence and social stigma associated with seeking help for mental disorders such as depression, anxiety, and PTSD. Premature discontinuation of psychological therapies is prevalent, particularly among younger demographics like millennials and Generation Z, who often face significant societal judgment. This research paper presents a computer science project that explores the potential of gamification and micro-AI to enhance retention and completion rates in cognitive behavioral therapy (CBT). The project develops an interactive application that employs gamification strategies to increase engagement and motivation in therapy sessions. Additionally, it integrates micro-AI for real-time mood analysis, offering personalized feedback and support, thereby deepening users' connection to the therapeutic process. With functional testing pass rate of 94%, the primary goal of this innovation is to improve mental health outcomes by mitigating the issues of adherence and premature therapy dropout, providing a scalable and technologically integrated approach to mental health interventions. This study evaluates the effectiveness of these interventions through quantitative metrics and user feedback, aiming to contribute valuable insights into the intersection of technology and mental health.

Keywords—*Gamification, Cognitive Behavioral Therapy, Micro-AI, Mental Health Interventions, Therapy Adherence, Millennials and Gen Z*

I. INTRODUCTION

With times constantly moving towards a digital era, mental health becomes one of the most important health factors to maintain throughout a typical human lifespan. Hence various therapeutic interventions are in place for mental wellbeing.

Mental health interventions are structured and evidence-based approaches, including psychological or educational methods, aimed at preventing the onset of mental health conditions and managing symptoms of psychiatric disorders. These interventions are designed to enhance cognitive, emotional, and behavioral functioning through various therapeutic techniques tailored to meet the specific needs of individuals [1].

Even with various practices, techniques that already exist, one of the most challenging aspects of keeping up with the generational gap and the shift of preferences that follow is that the archaic methods of therapy has difficulty keeping up with the newer generations.

Within the mental health interventions, the gold standard in mental health therapy is often considered as CBT. Although being the industry best practice, with the new generations the retentions and completion rates in therapy has plummeted. Maintaining adherence rates in therapy within millennials and gen Z has proven to be a challenge as engagement is on a decline. Relatability and interest invoking and the different thinking patterns of the newer generations often find that the archaic ways of therapy to be difficult to retain in with passing time.

Hence within from these current issues and the challenges arises an opportunity of exposing a research gap that requires the critical analysis and designing of an concept that tackle the above challenges of therapy adherence and completion rates that currently is declining the effectiveness of CBT.

II. DOMAIN BACKGROUND

A. Current Global Outlook

Although the topic of mental health is much of a lesser taboo subject, seeking help, treatments to better cope with mental ailments such as depression, anxiety and other mental illnesses is still something that is looked down upon and neglected. Mainly due to the judgement and the social backlash that is received by people with such ailments.

B. Cognitive Behavioural Therapy (CBT)

The robust efficacy of Cognitive Behavioral Therapy (CBT) across various psychological ailments is well-supported by numerous empirical studies. Butler et al. conducted a meta-analysis of 25 randomized trials involving over 2,000 participants, which substantiated CBT's superior effectiveness in managing anxiety disorders compared to control or non-intervention groups [2]. Complementarily, Hofmann et al.'s comprehensive meta-analysis, encompassing dozens of studies across nineteen countries, decisively confirmed that CBT

significantly lowers depression risk markers following treatment interventions [3]. Further emphasizing CBT's versatility, Powers et al. demonstrated its applicability in pediatric settings, where it effectively reduced symptoms among children diagnosed with obsessive-compulsive disorder, thereby illustrating CBT's broad therapeutic reach and its potential for adaptation to different patient demographics [4].

C. Therapy Adherence & Completion Rates

Recent studies highlight the concerning trend of increased dropout rates from psychological interventions, a phenomenon particularly prevalent across various generations within society. A meta-analysis focused exclusively on Cognitive Behavioral Therapy (CBT) studies by Linardon et al. uncovered a significant range of dropout rates, estimating between 35–56%, with dropout rates in IAPT (Improving Access to Psychological Therapies) settings specifically noted at 31% [5].

Expanding upon this data, Olfson et al. examined dropout rates from outpatient mental health care in the United States, finding that approximately 22.4% of patients terminate their treatment prematurely, with the highest dropout rates observed in the general medical sector at 31.6%, compared to the lowest at 15.1% in psychiatry. Additionally, the research found significant variances in dropout rates across different sectors and stages of treatment, with factors such as mental health insurance and psychiatric comorbidity influencing these trends [6].

Based on the study of the previous systematic reviews and different papers on current and past implementations, it is clearly susceptible that to effectively deliver and promote therapy adherence as well as promote and increase therapy completion rates, the fusion of CBT therapy with gamification or CBT therapy with AI enhancement implemented in segregation would produce a unsuccessful attempt to reach and achieve the underlying goal.

This is mainly as neither the two implementations as separate solutions bear fruit to address the issue of keeping the demographic to be catered engaged enough to keep retaining to the therapy roadmap. Hence to promote therapy adherence and completion rates within CBT therapy, gamification further complemented by micro-AI enhancements is necessary.

Gamification of therapy components ensure the successful delivery of CBT therapeutic components, micro-AI enhancements such as AI chatbots, ensure that real time feedback through progressive improvement ensures the successful engagements to uplift the adherence rates and completion of therapy. The amalgamation of gamification techniques with complimentary AI enhancements incorporated into CBT therapy ensures the adherence and completion rates are upheld through revamping the generic CBT therapy experience.

III. EXISTING WORK

A. Gamification of CBT Techniques

Sriwatanathamma [7] provide an intriguing case study focused on the application of game mechanics through a visual narrative serious game designed for millennials in Bangkok. This study implements the ABCDE model (Activating Events, Beliefs, Consequences, Disputation of Beliefs, and Effective

New Approaches) as a foundational structure to integrate CBT principles into a gamified format. This innovative approach seeks to make therapy more engaging and relatable for younger audiences, potentially increasing adherence and effectiveness [7]. However, one of the fundamental limitations noted in this study is the nascent state of research in the gamification of therapy, which makes it challenging to robustly assess the long-term impact and effectiveness of these interventions. Additionally, while the narrative-based game format can captivate users, it lacks mechanisms for real-life feedback and progress monitoring, often confining the user experience within predefined evaluation metrics that may not accurately reflect individual progress or setbacks. The study's reliance on predefined evaluation metrics could potentially misalign with the nuanced progress or unique therapeutic needs of individual users, thus questioning the long-term efficacy of such applications [7].

Grant [8] further extend the domain of gamified CBT interventions through their development of a mobile health (mHealth) application targeting adolescents. Their approach diversifies from typical gamified e-health solutions by enriching the reward and feedback systems to foster a more comprehensive and positive cognitive response [8]. Despite these innovations, the study identifies a critical limitation: the adaptation of gamification elements to culturally specific narratives sometimes leads to a lackluster engagement from users, undermining the potential success of the CBT intervention. This highlights the intricate balance required in designing gamified content that must be universally appealing yet effective across diverse cultural settings. The findings underscore the necessity for ongoing research to optimize gamification strategies within mental health treatments to ensure they are engaging, culturally sensitive, and therapeutically beneficial [8].

B. Systematic Reviews and Clinical Trials

In the context of gamification and mental health intervention adherence, Brown [9] conducted a systematic review focusing on the impact of gamified features in online therapy environments. Their analysis included more than ten major randomized controlled studies and identified a significant enhancement in adherence rates, especially noted in treatments for social phobia [9]. The review substantiates the effectiveness of gamification in increasing patient engagement, which is crucial for the success of web-based mental health interventions. However, the researchers also highlighted substantial limitations, including the constrained scope of increased adherence rates and the challenges presented by the scant amount of existing research on this topic [9].

Similarly, Pramana [10] explored the use of mHealth gamification in the treatment of child anxiety through CBT skill practices. This clinical trial illustrated how innovative gamification techniques could enhance treatment adherence and completion rates among children. Nevertheless, the study faced significant limitations due to its uncontrolled research design and the small number of participants, which may not provide a reliable reflection of broader usage patterns and poses questions about the robustness and applicability of the findings to a broader population [10].

C. Additional Existing Work in Gamification and AI

Sokoon represents a pioneering blockchain-based mental health service that offers tailored therapeutic programs primarily for Arabic-speaking populations. The platform integrates gamification and AI with CBT elements to enhance user engagement and cater to specific cultural nuances. The design of Sokoon is particularly focused on overcoming cultural barriers that restrict access to mental health care, thus playing a vital role in destigmatizing mental health issues within these communities [11]. While Sokoon has established itself as a significant cultural brand within Arabic societies, its cultural specificity could potentially restrict its applicability and expansion into non-Arabic contexts. This limitation highlights a critical area for further research: assessing the platform's AI-driven recommendations and gamified methods across varied cultural settings [11].

Merlynne employs an advanced AI engine designed to automate and personalize learning processes, which can also be applied to mental health contexts. This system adapts educational content to individual needs, potentially revolutionizing CBT by integrating personalization and engagement strategies [12]. However, the implementation of this AI in mental health settings must navigate potential pitfalls. If applied too mechanistically, there's a risk of alienating users, emphasizing the need for sensitive and adaptable intervention strategies. Furthermore, while the platform serves as a promising prototype for future AI-driven educational tools, its current market iteration may be more aspirational than operational. This underscores the ongoing need to balance innovation with user-centric design and functionality in AI applications within mental health [12].

SuperBetter is an app that leverages gamification to help users enhance their resilience and achieve personal goals by incorporating CBT principles into its gameplay. The app uses gaming mechanics to foster goal achievement and maintain a positive mental state [13]. Despite its general appeal, SuperBetter may not fully address the intricate details of mental health issues, which CBT typically focuses on. The effectiveness of its gamification techniques may vary among users, suggesting a need for further customization to maximize its therapeutic potential [13].

SPARX is an innovative, internet-based CBT program developed in New Zealand, aimed specifically at treating depression among young people. The program uses a fantasy game environment to deliver therapeutic content, providing an immersive and interactive way to learn and apply CBT techniques [14]. While SPARX has demonstrated success in helping young individuals manage depression, questions remain about its effectiveness across broader and more diverse populations or more complex psychological conditions [14].

IAware is a novel mental health intervention developed by Dias et al. (2020) that leverages advanced artificial intelligence to enhance self-awareness and monitor mental health conditions. This tool is designed to provide users with real-time insights into their emotional states and suggest customized interventions based on CBT principles [16]. One major limitation is privacy concerns as the continuous collection and analysis of personal data raise significant issues regarding data security and user

consent, potentially deterring user engagement. Additionally, the reliability of the AI's emotional analysis is crucial; inaccuracies in data interpretation could lead to inappropriate interventions, risking harm rather than helping users. Moreover, ensuring that the AI algorithms are adaptable to cultural and individual diversity poses a significant challenge, as variations in behavioral norms and communication styles across different demographics could affect the system's effectiveness and accuracy.

IV. PROPOSED DESIGN

A. High Level Architecture

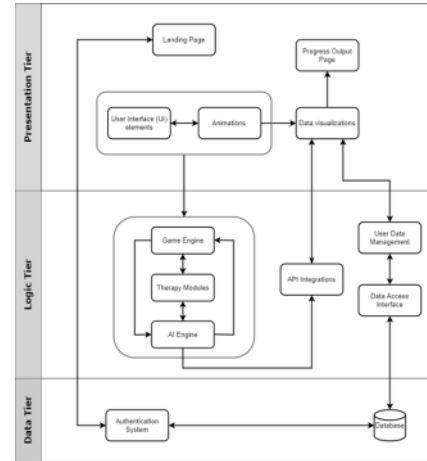


Fig. 1 Proposed architecture

As per Figure 1, the proposed system employs a multi-tier architecture, ensuring a robust and scalable application framework that separates concerns across three primary layers: presentation, logic, and data. This structured separation facilitates enhanced security, better user experience, and easier maintenance. The architecture diagram provided illustrates how each tier is designed to interact seamlessly with the others, ensuring efficient data flow and processing. The presentation tier is responsible for all user interface and experience components, the logic tier handles processing and decision-making, and the data tier manages data storage and retrieval.

At the foundation of the application, the Data Tier plays a crucial role in maintaining the integrity and security of user data. It includes an Authentication System that not only manages user logins but also ensures that user credentials are verified and that users are granted access appropriate to their level. The Database is another critical component, securely storing user data, including therapy progress, preferences, and session details, along with AI-generated insights which are pivotal for personalized therapy experiences.

The Logic Tier is the core of the application where major processing occurs. It houses the Game Engine, which is essential for driving the interactive elements of the app, including gameplay mechanics and reward systems tailored to enhance therapeutic engagement. Therapy Modules deliver a range of evidence-based interventions, customized to meet the specific

therapeutic goals of each user. The AI Engine plays a vital role in analyzing user data and gameplay interactions to offer personalized therapeutic recommendations and adaptations. This tier also includes API Integrations for enhancing app functionality and a Data Access Interface to ensure secure and efficient communication with the Data Tier.

The Presentation Tier focuses on user engagement and data representation. It features Data Visualizations that present complex data and progress metrics in a user-friendly manner through charts, graphs, and progress trackers. The Progress Output Page offers a consolidated view of user achievements and therapy outcomes, critical for motivating continued user engagement. Animations within this tier add a dynamic element to the user experience, enriching user interactions with visual feedback and rewards. Lastly, the User Interface Elements and Landing Page are designed to be intuitive and welcoming, encouraging user interaction and simplifying navigation across various features of the app.

B. Design Pradigm

Object Oriented Analysis and Design (OOAD) was chosen as the Design Methodology as it enables the following,

- Modelling Real-world Entities
- Modularity and Reusability
- Dynamic Behavior Modeling
- User-Centric Design
- Iterative Development
- Collaboration and Communication
- Prototyping Capabilities

The project objectives and requirements are well aligned with a model-driven architecture for software systems focused on object modelling, modularity, dynamic behavior representation, user-centric design, iterative development, collaboration, and prototyping which also keeps in line with design trends.

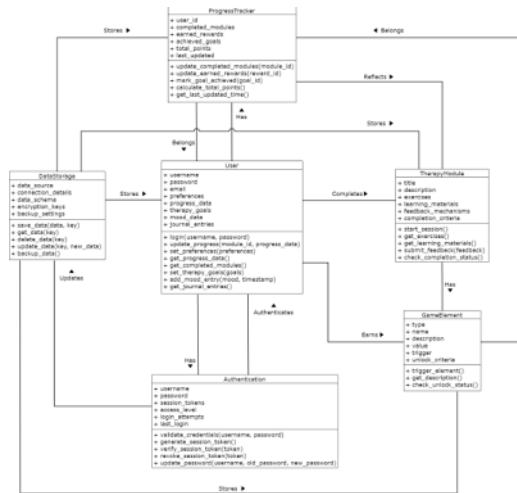


Fig. 2 Class diagram

As the author has opted to use OOAD, the Figure 2 depicts the class diagram for main entities showcasing their attributes, methods, and relationships.

The proposed solution takes the stand on the framework [15] that has been developed in line with the behavioral science and gamification. The framework analyzes human motivation through eight Core Drives. These Core Drives are the essential elements that fuel human behaviors [15] and leverage those towards creating a comprehensive strategy which can make a solid foundation for enhanced engagements rates within therapy modules. Thus according to the framework [15], the system process workflow is as Figure 3.



Fig. 3 System process flow

V. IMPLEMENTATION

A. Selection of Technology Stack

Names should not be listed in columns nor group by affiliation.

The selection of the technology stack for this project was driven by the need for robust, flexible, and efficient tools to build and support the application's sophisticated functionalities. For programming languages, Dart was chosen for its versatility and strong support for both front-end and back-end development. Flutter allows for rapid, seamless mobile UI construction, making it ideal for developing highly interactive user interfaces. The development framework Flame + Rive was selected to enhance the application with rich animations and real-time game elements, crucial for engaging user experiences. Flame was used not only as a UI library but also to ensure that the graphical aspects are tightly integrated with the game mechanics. Additional support libraries like Provider, Rive

Flutter Widget, Hive, and Firebase enhance state management, local storage, and cloud integration, respectively. Flare further supports advanced animations. The development environment is supported by VS-Code, which offer powerful coding tools and an efficient testing environment. Version control is managed through Git and GitHub, ensuring robust version management and collaborative development. Collectively, these technologies were selected to optimize development efficiency, ensure scalability, and enhance user engagement through a responsive, intuitive interface and backend robustness.

TABLE I SUMMARY OF TECHNOLOGY SELECTION

Component	Tool(s) / Technology(s)
Programming language	Dart
Development framework	Flame / Rive
UI library	Flame
Other libraries	Provider / Rive / Flutter Widget / Hive / Firebase / Flare
IDE	VS-Code
Version control	Git / GitHub

B. Implementation of Core Functions

1) *Game Element Integration*: Adherence to therapy is crucial for its effectiveness. Integrating game elements addresses this challenge directly by making self-care practices more enjoyable and rewarding. Users are more likely to stick with activities if they find them engaging and feel a sense of achievement. Additionally, these elements can cater to different learning styles by offering a more interactive and dynamic approach to therapy, potentially increasing its accessibility and effectiveness for various users. However, it's essential to implement game elements thoughtfully and ethically. Focus on motivation and positive reinforcement with rewards and achievements as shown in Figure 5. Ultimately, the goal is to empower users on their personal growth journey, and game elements should serve as supportive tools within that framework.

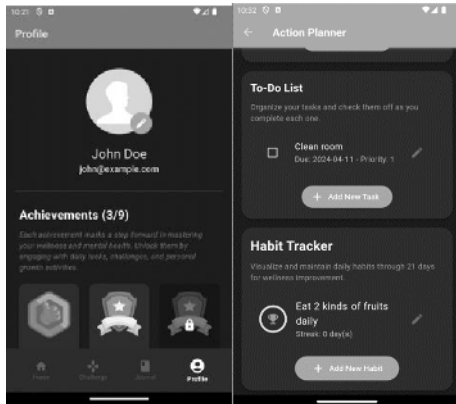


Fig. 5 Game elements in UI

2) *Therapeutic Sample Exercises & Progress Tracking*: These features are not mere add-ons but essential building blocks for engagement. By offering practical exercises, even if simplified, the app allows users to apply acquired knowledge and experience the benefits firsthand. Simultaneously, progress tracking serves as a powerful motivator. Seeing their progress visually represented, be it through completed exercises or points earned, incentivizes users to stay on track and strive for further improvement. Furthermore, these features personalize the therapy experience. Users can choose exercises that resonate with their needs and track their progress at their own pace, fostering a sense of ownership and control over their journey as shown through the UI in Figure 4.

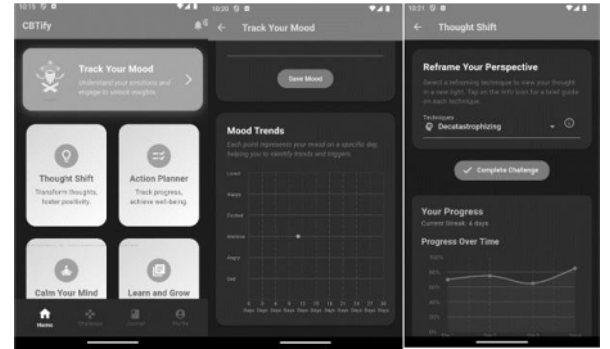


Fig. 4 Sample exercise and progress tracking UI

3) *Therapy Module Selection*: Therapy is not a one-size-fits-all approach. Offering diverse modules caters to this individuality. Users can explore relaxation techniques, delve into cognitive restructuring exercises, or choose modules aligned with specific challenges like sleep or anxiety. This variety not only increases user engagement but also fosters a sense of agency and control over their therapy experience. Furthermore, providing a structured navigation system prevents users from feeling overwhelmed by a vast amount of information. The carefully curated modules act as stepping stones, allowing users to progress at their own pace and gradually build their knowledge and skills. This structured approach can significantly enhance comprehension and retention of therapeutic concepts.

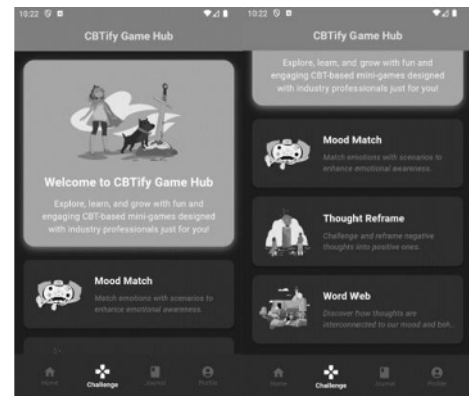


Fig. 6 Therapy module selection

VI. TESTING AND EVALUATION

The implemented prototype was tested within a multitude of testing environments. Based on the requirements of the functionalities to be tested, the following testing was separated as,

- **Functional Testing:** Focus on the technical and functional aspects of the system to ensure the how the functional requirements of the system have been met.
- **Structural Testing:** Focus on structural and non-functional aspects of the system to ensure how the non-functional requirements if the system have been met

A. Functional Testing

The below functional tests were conducted which were identified from the functional requirements (FR) in the below table,

TABLE II FUNCTIONAL TESTING

ID	User action	Total Test Cases	Actual passed test cases	Remark
FR 01	User completes a CBT session using core therapeutic functionalities.	10	10	100% Pass
FR 02	User accesses the progress tracking and reporting feature after completing several sessions.	10	9	90% Pass
FR 03	User engages with gamification elements by completing specific therapeutic tasks.	10	10	100% Pass
FR 04	New user attempts to register with the application.	10	9	90% Pass
FR 05	User accesses the progress visualization tool after completing multiple CBT sessions.	10	9	90% Pass

Inclusive of the above mentioned functional requirements, a total of 14 functional requirements were tested to ensure the application is working as intended. As intended, all the functional requirements stated were working as expected with a 100% pass rate.

B. Structural Testing

A white box testing was conducted to test the non-functional requirements (NFR) of the developed prototype. Testing was done to ensure that the all the intended and stated non-functional

requirements were working as intended. Upon testing all the requirements tested with a 100% pass rate as expected of their intended behavior

C. Evaluation of Prototype

In addition to the functional an structural testing, some other evaluations were conducted to ensure a through testing and evaluation environment to support the aim of the research and the proposed prototype which are,

- **Qualitative Evaluations:** Domain expert feedback through thematic analysis
- **Quantitative Evaluations:** Usability metrics and analyzing completion rates

1) Qualitative Evaluation

To critically evaluate the proposed prototype, some feedback was taken after presenting to some of the domain specialists and technical experts.

TABLE III SELECTION OF EVALUATORS

CAT ID	Category
1	Experts with research experience in the fields of Gamification
2	Experts with domain expertise in the fields of Mental Health, Psychiatry, Psychology, Counselling
3	Possible end-users of the applications patients or people seeking therapy

TABLE IV QUALITATIVE ANALYSIS

CAT ID	Criterion	Theme	Summary of Opinion
2	Concept	Domain Expertise	Domain experts appreciate the innovative concept but emphasize the necessity of maintaining the therapeutic integrity of CBT. They advocate for a balance between gamification and the core principles of therapy.
2	Solution	Practical Application	Both domain and technical experts commend the solution's potential to address current gaps in mental health treatment accessibility. Domain experts call for ongoing clinical validation to ensure effectiveness.
1	Scope	Technical Expertise	Technical experts highlight the app's robust architecture and the effective use of Flutter for cross-platform functionality. They suggest focusing on scalability and performance as critical areas for future development.
1	Architecture of Solution	System Design	The seamless integration of AI and gamification within the app's architecture receives praise. Technical experts recommend continuous improvement in data handling and security measures to protect user privacy.
1	Implementation of Solution	Development Approach	The implementation strategy, particularly the user-centered design and iterative development process, is well-regarded. Experts suggest

CAT ID	Criterion	Theme	Summary of Opinion
			incorporating more user feedback to refine UI/UX and functionality.

2) Quantitative Evaluation

Usability testing focused on how real users interacted with prototype, assessing user interface intuitiveness, engagement level, and overall satisfaction. Refer the Category id provided in the TABLE III

TABLE V QUANTITATIVE ANALYSIS

CAT ID	Criterion	Theme	Summary of Opinion
3	Usability	End User Experience	End users' express satisfaction with the app's usability and the motivational aspect of progress tracking. Feedback indicates a desire for more customization options to enhance personal relevance and user comfort.

D. Limitations of Testing & Evaluation

The testing phase lacked defined metrics for assessing the efficiency of gamification, relying instead on qualitative before-and-after analyses that did not capture the full impact of these features. Additionally, the sensitive nature of mental health data made it difficult to gather a sufficiently large and diverse sample size for usability testing, as recruitment had to be conducted through professional channels similar to a human trial, introducing regulatory and ethical complications. The evaluation also faced issues; the sample size and diversity were not representative of the broader target demographic, limiting the generalizability of findings. Moreover, the evaluation's duration was too brief to assess long-term engagement and sustained therapeutic benefits, which are critical for determining the effectiveness of the application over time.

VII. CONCLUSION AND FUTURE WORKS

The exploration of gamification and artificial intelligence (AI) to enhance therapy adherence and completion rates in Cognitive Behavioral Therapy (CBT) within this research marks a significant stride towards innovating mental health care, by bridging traditional therapy methodologies with the dynamic capabilities of modern technology. This thesis illuminates the path forward where mental health interventions are not only more accessible and engaging but also personalized and ethically grounded.

Future iterations of the app could leverage learning models to offer real-time, highly individualized therapy sessions, enhancing therapeutic outcomes through tailored interventions that resonate deeply with individual experiences. Additionally, the integration of emerging technologies such as Augmented Reality (AR) and Virtual Reality (VR) into the gamified CBT framework promises immersive therapeutic experiences that could redefine traditional therapy and make mental health care more appealing and accessible. Ongoing collaboration with

mental health professionals, technologists, and users is essential to ensure these advancements remain ethically responsible and clinically effective. By continuing to innovate and expand the impact of digital interventions, this research contributes to a more effective digital mental health landscape, advocating for continuous improvement and dialogue to keep pace with technological advancements and ethical standards, thereby shaping a future where mental health care is engaging, personalized, and accessible worldwide.

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