Case Study

DIGITAL HEALTH

DIGITAL HEALTH
Volume 10: 1–20

DOI: 10.1177/20552076241263317
journals.sagepub.com/home/dhj

Sage

A gamified cognitive behavioral therapy for Arabs to reduce symptoms of depression and anxiety: A case study research

Nourhan A. Amer[1], Samaa M. Shohieb[1], Waleed Eladrosy[2], Shilong Liu[3], Yunyoung Nam[3] and Samir Abdelrazek[1]

Abstract

Background: Depression and anxiety are prevalent mental health issues addressed by online cognitive behavioral therapy (CBT) via mobile applications. This study introduces Sokoon, a gamified CBT app tailored for Arabic individuals, focusing on alleviating depression and anxiety symptoms (DASDs).

Objectives: The objectives of this study were to: Evaluate the effectiveness of Sokoon in reducing symptoms of depression and anxiety. Assess the usability of the intervention through user engagement and adherence to CBT skills.

Methods: A single-group pre–post design evaluated Sokoon's impact on adults with DASDs. In consultation with psychiatrists, Sokoon integrates evidence-based skills such as relaxation, gratitude, behavioral activation, and cognitive restructuring, represented by planets. Its design incorporates Hexad theory and gamification, supported by a dynamic difficulty adjustment algorithm. The study involves 30 participants aged 18–35 (86.7% female), specifically those with mild to moderate depression and anxiety.

Results: Based on a sample of 30 participants, Sokoon, a smartphone-based intervention, significantly reduced symptoms of depression and anxiety ($d = 2.7$, $d = 3.6$, $p < 0.001$). Over a two-week trial, participants experienced a notable decrease in anxiety and depressive symptoms, indicating the effectiveness of the model. Sokoon shows potential as a valuable tool for addressing DASDs.

Conclusion: Sokoon, the gamified CBT application, offers an innovative approach to increasing CBT skills adherence and engagement. By leveraging Hexad theory and gamification, Sokoon provides an enjoyable and engaging user experience while maintaining the effectiveness of traditional CBT techniques. The study findings suggest that Sokoon has a positive impact on reducing symptoms of depression and anxiety.

Keywords

Cognitive behavioral therapy, gamification, hexad theory, DDA, depression, anxiety

Submission date: 2 March 2024; Acceptance date: 29 May 2024

Introduction

Mental disorders are illnesses characterized by changes in thought, emotion, or behavior (or any combination of these) that are connected to suffering and/or poor functioning, giving rise to a wide range of issues for people, such as disability, discomfort, or even death.[1] Depression is a widespread and dangerous medical condition that has an adverse impact on how one feels, thinks, and behaves.[2] Symptoms of depression include sadness and/or a loss of interest in previously appreciated activities. It is estimated that in any given year, depression affects one in 15 adults

[1]Information Systems Department, Faculty of Computers and Information, Mansoura University, Mansoura, Egypt
[2]Computer Science Department, Faculty of Computers and Information, Mansoura University, Mansoura, Egypt
[3]Department of ICT Convergence, Soonchunhyang University, Asan, Korea

Corresponding authors:
Shilong Liu, Department of ICT Convergence, Soonchunhyang University, Asan 31538, Korea.
Email: m17856515276@163.com

Yunyoung Nam, Department of ICT Convergence, Soonchunhyang University, Asan 31538, Korea.
Email: ynam@sch.ac.kr

(6.7%), and 16.6% of people (or one in six) will experience depression at some point in their lives.[2] About 4% of people worldwide are thought to suffer from an anxiety disorder at the moment. Anxiety disorders are the most prevalent mental diseases globally, affecting 301 million individuals in 2019.[3] Previous studies have demonstrated a correlation between greater rates of trait anxiety and depression and a lower socioeconomic position.[4] Additionally, anxiety and depressive symptoms were substantially correlated with every aspect of life quality, indicating a decline in quality of life when these symptoms are present. Research indicates that there is a correlation between poor physical and social functioning and symptoms of anxiety and depression.[5]

Most mental health organizations support Cognitive Behavior Therapy (CBT) as an evidence-based therapy for treating and managing depression and anxiety.[6] However, access to CBT delivered by specialists is still limited for many patients. This limitation stems not only from a scarcity of specialized practitioners but also from other factors, such as the need for patients to travel and attend during normal working hours, as well as the cost.[6] Therefore, the benefits and practicality of self-help treatments such as computerized CBT (CCBT), which is self-help CBT using a program on a website or a computer without Internet access, have been appealing. It is expected that self-help CBT will be an effective intervention, particularly for mild-to-moderate depression.[7,8] Computerized cognitive behavior therapy can be used as a stand-alone treatment or as part of a stepped-care treatment plan and is beneficial for people with anxiety and/or depression.[9]

Gamification and serious games are traditionally defined as the use of game-playing components, such as points and scoring, for goals other than play, most commonly to promote motivation and enhance abilities.[10,11] Gamification has recently attracted more and more attention as a cutting-edge method of treating mental illness.

It is clear from empirical evidence that gamification has a positive impact on mental health such as decreasing symptoms of anxiety and depression,[12] domains and is a revolutionary field to explore.[13] According to some research, gamification has the potential to increase user engagement and adherence to mental health applications, which can enhance the effectiveness of therapeutic-based apps (such as CBT) and minimize depression symptoms. It may stimulate reward-mediated brain pathways, prompting pleasurable feelings that may counter some of the negative feelings associated with depression. In their opinion, gamified mental health apps will be superior to those without gamification in terms of reducing depression symptoms and encouraging adherence.[14] Another study suggests that the design of a gamified app, which incorporated game components such as points, awards, and progress tracking, may have enhanced participants' motivation and engagement in meditation practice, contributing to the app's efficacy in reducing symptoms of depression.[15] The number and sophistication of "mHealth" interventions have grown along with the prevalence of mobile phones in everyday life, and many health-related smartphone apps now feature gamification.[16,17] A study found that gamified apps can reduce anxiety and enhance the impact of mobile interventions on health and well-being.[18] Several studies have shown that gamified CBT interventions can be successful in reducing symptoms of anxiety[16] and depression.[19–22]

Recently, gamification has attracted scholarly attention as a tool for changing behavior in a variety of contexts. Several experts emphasize the importance of adapting material to the needs of different users when designing gamification, such as by employing the gamification user types hexad typology.[23] Based on their capacity to be motivated by intrinsic factors (such as self-realization) or extrinsic factors (such as rewards), Marczewski hypothesized six main user categories: Socializers, Free Spirits, Achievers, Players, Disruptors, and Philanthropists.[24,25] Philanthropists are driven by purpose and altruism, while Socialisers seek social connections. Free Spirits value autonomy and creativity, Achievers strive for competence and progression, and Players are motivated by extrinsic rewards. Disruptors, on the other hand, are motivated by triggering change and pushing boundaries. They may disrupt the system to induce positive or negative changes. These user types inform the design of gamified systems, with tailored design elements suggested to address the motivations of each type.[25]

The hexad theory is a model used in gamification that aims to address the challenge of personalizing gamified systems to match users' personalities. It provides a framework for mapping user personality traits onto various design elements to create more tailored and engaging experiences. The hexad theory helps designers understand different user types and design gamified systems catering to individual preferences and motivations.[25] However, there is limited research on the use of Hexad theory and gamification in CBT applications. The majority of research endeavors have focused on enhancing cognitive behavioral therapy (CBT) techniques across skills by incorporating a variety of gamification elements.[15,16,19–22] Only one study[26] has utilized the Hexad theory with gamification components but for diagnosis rather than treatment. Although the hexad theory idea is well-known in the field of user experience design, its application in treatment—specifically, in games that are based on CBT—is still relatively new.

One problem with many traditional CBT games is the fixed difficulty of each level. The difficulty is typically predetermined by the designers, regardless of the skill level of each player. For some players, this makes the game levels either extremely challenging or absurdly simple. Dynamic Difficulty Adjustment (DDA) is a method for resolving this issue.[27] Dynamic difficulty adjustment is an AI-based technology that permits attribute and behavior changes

in-game during play. Dynamic difficulty adjustment evaluates player performance and modifies the game's difficulty to reflect the player's abilities.[27] It keeps them from getting bored (when the game is too easy) or frustrated (when the game is too difficult).[28] Dynamic difficulty adjustment aims to provide players with a challenging experience while keeping them interested until the end.[28]

In this paper, we provide an overview of the steps we took to create a gamified mobile health CBT intervention called Sokoon. Our goal is to reduce symptoms of depression (mild to moderate), anxiety in adults over 18 by leveraging the field of CCBT. We aim to provide the best results by incorporating techniques such as Hexad theory, gamification, and DDA. Gamification can attract users and encourage them to seek treatment, the hexad theory allows for customization based on different user types, and a DDA algorithm to improve efficiency and results. By adding more personalization, we believe that Sokoon can be more effective in addressing the unique needs of each individual and helping them manage their symptoms of depression and anxiety. Sokoon is one of the first applications to integrate these elements in a CBT intervention. We hope that Sokoon can serve as a useful tool in the larger effort to improve mental health outcomes and increase access to evidence-based treatments.

Methods

Participants

A random sample of 30 adults aged 18 years or older was selected to participate in the study. Participants were chosen after confirming that they exhibited mild to moderate levels of depression and anxiety. Each participant received a detailed explanation of the experiment before providing informed consent. We obtained written informed consent from all participants before their involvement in the study, ensuring that they were fully informed about the research process and their participation. Ethical approval was obtained from the ethics committee of Mansoura University's Faculty of Computers and Information. We gathered descriptive demographic presents information about the participants, including age, gender, education level, marital status, and economic status.

The inclusion criteria for all participants were as follows: (a) Adults aged 18 years and over. (b) Egyptian nationals. (c) Individuals exhibiting mild to moderate symptoms of depression and/or anxiety, as assessed by standardized measures such as the Patient Health Questionnaire-9 (PHQ-9) and Generalized Anxiety Disorder-7 (GAD-7). (d) Proficiency in Arabic language. (e) Provision of informed consent.

The exclusion criteria were as follows: (a) Individuals below 18 years. (b) Non-Egyptian nationals. (c) Severe symptoms of depression and/or anxiety, as indicated by clinical assessment or self-report. (d) Inadequate proficiency in Arabic to engage with intervention materials. (e) Presence of cognitive impairments or neurological conditions that may hinder participation. (f) Lack of willingness or ability to provide informed consent.

The intervention: Sokoon app

Sokoon is a smartphone app-based symptom treatment tool designed specifically for Arab individuals with depression and anxiety.

The therapeutic components. In developing our app, Sokoon, we utilized CBT, which is an evidence-based therapy for the treatment and management of depression and anxiety.[6] It is a therapeutic approach that typically involves various exercises and written material such as worksheets.[29] Cognitive behavioral therapy can be divided into various components, including different skills and learning objectives.[16] To determine which skills to include in our app, we conducted extensive research and consulted with a psychiatrist. This process was challenging, but ultimately helped us to identify the most effective therapeutic components to incorporate into Sokoon.

Gamification elements and hexad theory. The Hexad User Types framework, developed by Andrzej Marczewski,[24,25] classifies users based on their motivations and preferences in gaming systems. The framework consists of six user types: Achievers, Socializers, Free Spirits, Philanthropists, Players, and Disruptors.

In the following, we explore how we integrated CBT techniques with different user types:

- Achievers are motivated by achieving goals and achieving success. They thrive on challenges and measurable progress. We have incorporated CBT techniques by Including a progress tracker whereby successful completion of specific challenges or milestones unlocks new relaxation exercises.
- Free spirits are driven by independence, creativity, and self-expression. They value the freedom to explore and experiment. We provide them with many choices. For example, in Planet Relaxation, they can choose their favorite music, favorite exercise, gratitude practices that match their preferences, and customization features.
- Philanthropists are motivated by making a positive impact and helping others. They value altruism and social causes. To engage them in CBT techniques, we offered surprise messages urging the benefits of relaxation, gratitude, cognitive restructuring, and social activities and emphasizing the benefits of these techniques not only for personal well-being but also for promoting empathy, compassion, and positive change in others.

- Players are motivated by external rewards. They will do everything they can to get rewarded within the system, regardless of the type of activity. We provide points, rewards, and badges for all skills.
- Disruptors are driven by the need to bring about change. They often try to impose positive or negative changes on the system by directly upending it. To engage them in CBT, throughout the game, provide unexpected tasks or activities that motivate players to pause and practice good habits. At any point, they can erase all of their progress across all planets and begin anew.
- Socializers are driven by relationships. They want to socialize and engage in communication with others. To engage them in CBT, we provide them with various ideas for social activities they can engage with others in their lives.

Table 1. Gamification elements used in Sokoon.

Gamification elements	Used in Sokoon	User type
Points	Points are earned daily in each mini-game and activity. Users can save them and spend them in games, avatar customization, and open new messages.	Player
Badges	When finishing any planet.	Player
Customization	Users can customize their avatars.	Free sprite
Anonymity	The user can hide his name.	Disruptor
Anarchy	The user can burn all his progress on all planets at any time and start again.	Disruptor
Levels	In the "positive word" mini-game.	Achiever
Random rewards	– By performing breathing exercises for more than ten minutes, users can win random gifts. Users receive random prizes whenever they reach the top score in any mini-game on the app. Every 24 h, he gets a gift if the application is opened (found on the home page under the name "Daily Prizes"). Reward like (between 10 to 5 points and accessories that allow players to customize their characters, and unlock a new message.)	For all user types.

In Table 1, we'll go through how we included gamification elements for every user personality based on hexad theory into our app, Sokoon.

Dynamic difficulty adjustment

We added DDA to a game that was played as a part of the intervention. The game's goal was to enhance cognitive abilities, and DDA was used to adjust the difficulty level to each player's performance and skill level.

Dynamic difficulty adjustment which is based on player performance is a technique used in games to modify the level of difficulty. For instance, the threats the player faces in the survival horror game Left 4 Dead are changed depending on how well they perform. The game becomes harder as you get better at it.[30] Performance-based DDA research has already examined several player skill indicators, including task completion time and player scores. Additionally, game aspects can be changed, ranging from straightforward modifications like adjusting the game's speed or object count to more complicated ones like changing how computer-controlled foes behave or dynamically creating the game's landscape.[31]

A different approach is to compare a player's performance right now (Cp) to what we would expect them to be doing then (Ep[t]) so performance can be calculated as in equation (1):[27]

$$Performance = \frac{Cp}{Ep[t]} \quad (1)$$

So, a rating adjacent to 1 indicates that the challenge is suitable for the player. Player performance evaluation can be done by comparing current stats to ideal/reference stats over a specific period.

There are three ways that this adjusting method might be used:

1. Between levels: (After the conclusion of one level and before the start of the following levels).
2. Regularly inside a level: it can be used regularly throughout a level's gameplay to periodically dynamically update the level difficulty while the player waits for the level to be completed. In that situation, the level average completion time determines how frequently the DDA algorithm is applied.
3. At checkpoints: This is identical to the second version but does not employ predetermined intervals for DDA recalculations. It can be used when a player reaches

certain places (checkpoints) in a level or when they partially finish a subtask along with the route.

We applied the DDA technique on the positive planet. We gave more details on how to apply this in the positive planet in the following sections.

The proposed model (Sokoon)

Our proposed model aims to assist individuals suffering from depression and anxiety, by utilizing CBT skills such as cognitive restructuring, relaxation, self-love, socialization, behavior activation, gratitude, and problem-solving. We incorporate gamification techniques, the user hexad therapy, and the DDA algorithm into our model to enhance its effectiveness.

In our prototype, we will introduce and explain four of the CBT skills that we have selected: cognitive restructuring, relaxation, behavior activation, and gratitude.[32] These skills were chosen based on their proven effectiveness in treating depression and anxiety and are expected to have a positive impact on the target population.

To make the CBT skills more engaging and enjoyable, we designed them in the form of planets. Each skill was assigned a planet, which contains a set of activities and mini-games related to that particular skill. Our goal was to create a fun and interactive experience for users and to prevent them from feeling bored or disengaged while using the app.

Let's explain each step of our Arabic language model designed to help adult individuals in Arabic countries dealing with depression and anxiety, with the aid of figures. At every stage of the application, we collected and stored specific data for usability metrics, which will be explained.

The first page of our application is the registration page, where we collect essential data such as the user's username, age, gender, and user avatar, as shown in Figure 1(a). The age must be stated as 18 years or older, and we save each user's data to aid us in behavior analysis. Once the user has entered their data, the application verifies that the age is over 18 years old and that all data have been entered. Then the second-page loads, which is the user-gamified test (the test explanation in the instrument subsection) Figure 1(b), and its result appears for the user to know his personality in gaming Figure 2. After that, the main page loads (Figure 1(c)). In Sokoon, we incorporate various gamification elements such as badges, customization, levels, points, and prizes, which are listed in Table 1.

The main page of the application is divided into three parts, as depicted in Figure 1(c). At the top of the page, the user's name, avatar photo, and app coin called "nour" are displayed. The main page itself comprises seven planets, each serving a specific purpose, which are the self-love planet, problem-solving planet, positive planet, relaxation planet, gratitude planet, activities planet, and social planet, and the main (home) icon.

The main icon contains:

(a) Positive messages: Users receive one positive message per day, accessible by clicking on the message icon. Additional messages can be unlocked using coins within the app.
(b) Depression test (PHQ-9) (Figure 3): This test is not a screening tool for depression, but it is used to track the degree of depression and the effectiveness of its treatment.[33] Users could see their results in real-time (Figure 4).
(c) Anxiety test (GAD-7) (Figure 5): This test is one of the strategies that can be employed to detect anxiety or evaluate its severity.[34]
(d) Badges page (Figure 6): This page displays all the badges the user has earned. Users can earn more badges by playing more mini-games.
(e) Progress track page (Figure 7): provides a visual representation of the user's progress across different planets, with phrases appearing when standing over a specific planet icon that changes based on players' progress and encourages them to continue. This helps users to easily know which planets they have completed and which are pending.

As a prototype, we are focusing on only four planets: the Positive Planet, the Relaxation Planet, the Gratitude Planet, and the Behavior Activation Planet.

The positive planet

This planet focuses on cognitive restructuring skills. Negative emotions, along with their physical and behavioral effects, can be changed using the cognitive restructuring technique. This involves identifying the false negative beliefs that underlie negative emotions and replacing them with more positive coping concepts.[29,35]

Based on this technique, we developed an activity that helps patients replace distorted thoughts with positive ones when they are exposed to negative situations. The psychiatrist guided the format of these questions, affirming their appropriateness specifically for adults. The player will not fail to identify his false negative beliefs because they are a set of questions that he asks himself.

The purpose of this written method is for the user to get used to applying it in his general life when he is exposed to any annoying situation that affects him negatively. Figure 8 illustrates the steps of thought analysis used in our app, which are explained in more detail in Appendix 1.

This planet also features a game called the Positive Word Game "mini-game" (see Figure 9). The game presents a collection of positive and negative words within a limited time, after which the words disappear and a new collection of

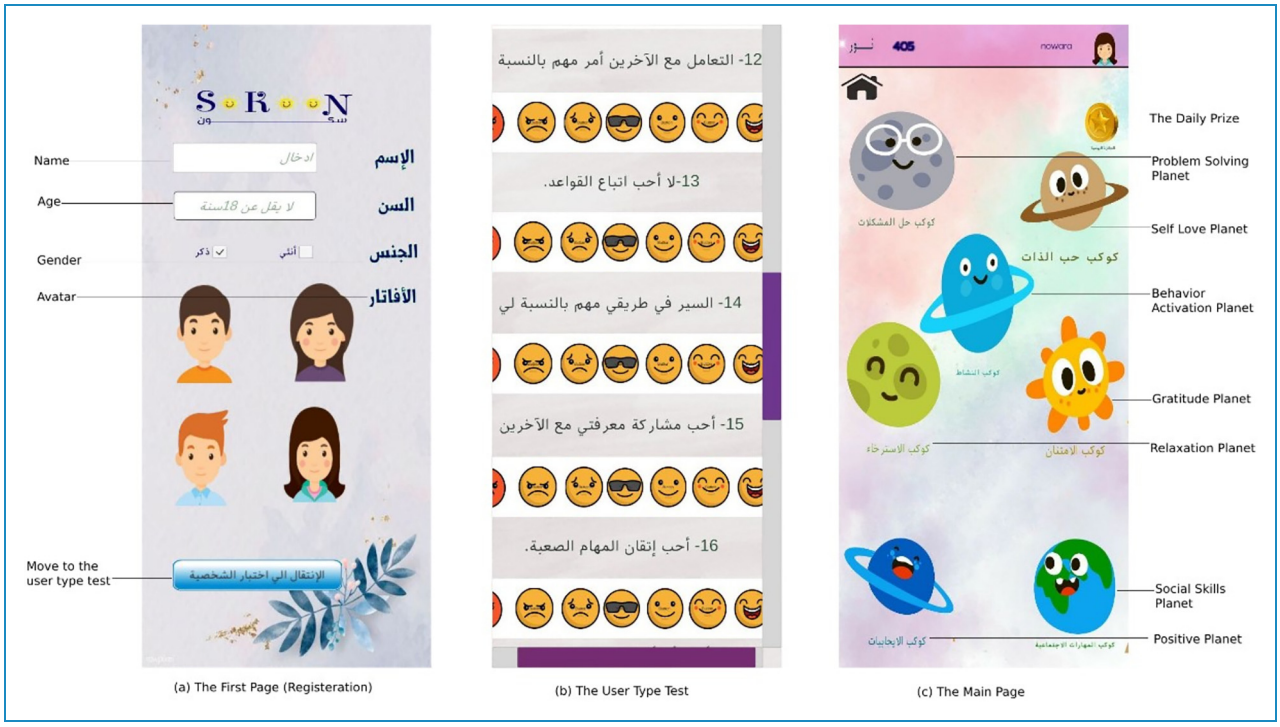

Figure 1. The registration pages and the main page of the app (Design Credits: The author).

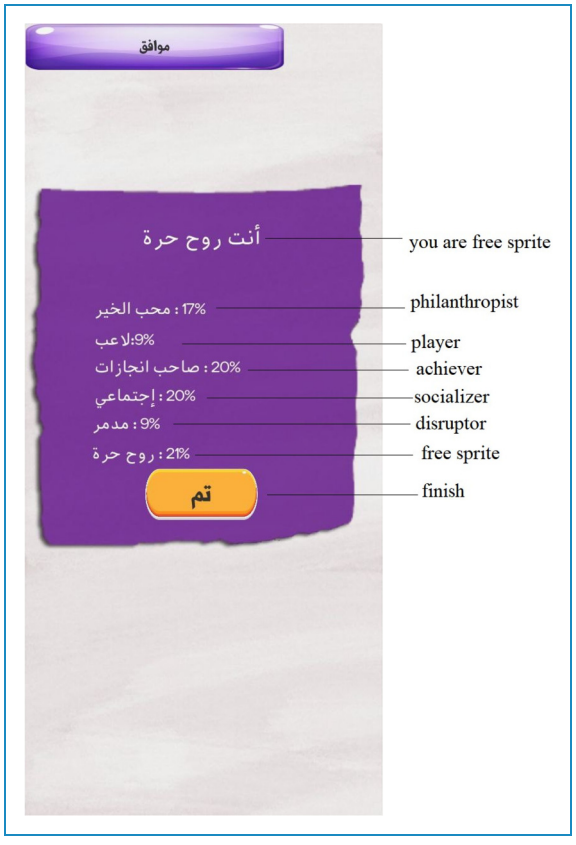

Figure 2. The result of the user type test. (Design Credits: The researcher).

words appears. The player's goal is to collect as many positive words as possible before they disappear. To enhance the player's experience, we applied a DDA algorithm in the game.

How is DDA applied on the positive planet?

We implemented a DDA algorithm in our gamified CBT application to personalize and adapt the difficulty level of the positive word mini-game (Figure 9) based on the user's performance and preferences. At the end of each level, the following steps show how DDA is applied:

1. Set the initial time limit for each level.
2. Define the collection of positive and negative words for each level of gameplay.
3. Start the level.
4. Display the collection of words to the player.
5. Allow the player to select positive words within the time limit.
   - Number of whole positive words (Nap)
   - Number of whole negative words (Nan)
6. When the time limit is reached, calculate the player's performance measures:
   - Count the number of positive words collected by the player (nPos).
   - Count the number of negative words collected by the player (nNeg).
   - Calculate the player's success rate: (Nan-nNeg)/Nan.

Figure 3. The depression test (PHQ-9).[33] (Design Credits: The researcher).

Figure 4. The depression test result.

7. Compare the player's success rate with the target success rate for the level.
   Target success rate = nPos/Nap.
8. Adjust the difficulty level based on the success rate:
   If the player's success rate is lower than the target success rate, make the game easier (Increase the time limit for the next level).
   If the player's success rate is higher than the target success rate, makes the game more challenging (Decreases the time limit for the next level).
   If the player's success rate is equal target success rate, maintain the current difficulty level
9. Generate a new collection of words for the next level.
10. Repeat steps 4–9 for each level of the game.
11. End the game when the player completes all levels or when the player chooses to quit.
12. Calculate the player's final score based on the total number of positive words collected throughout the game.
13. Display the final score and any other relevant game statistics.

For example: if the game's first level has eight positive words and eight negative words after the user plays the first level, the user gets three negative words and seven positive words:

$$\textit{The player's success rate} = \frac{8-3}{8} = .62$$

$$\textit{The target success rate} = \frac{7}{8} = .87$$

Figure 5. The anxiety test (GAD-7).[34] (Design Credits: The researcher).

The player's success rate < the target success rate, then the game is hard for the user so the time will be increased in the next level.

The DDA algorithm affects some factors, including the level's duration and word display frequency and speed. Based on how well the player performs, the algorithm dynamically modifies the player's presentation of positive and negative terms at different rates. For instance, the algorithm gives the player more time to make decisions if they are having trouble or are constantly choosing unfavorable terms. On the other hand, if the player is doing well and selecting constructive phrases quickly, the algorithm quickens the speed to keep the degree of difficulty suitable.

This adaptable method not only encourages positive reinforcement and cognitive restructuring but also preserves motivation and enjoyment, which in turn improves mental health and user satisfaction in general.

The relaxation planet

This planet focuses on relaxation skills and includes breathing exercises (Figure 10(c)), relaxation videos, relaxation music, and a relaxation mini-game. The relaxation mini-game involves collecting a series of stars while listening to relaxing music (Figure 11(b)).

In the relaxation part (Figure 10(a)), there is a collection of music available, allowing users to choose their favorites. Users can control playback, including starting, stopping, and playing the selected music. The following messages appear on screen when listening,

1. Find a quiet and comfortable space
2. Close your eyes or soften their gaze
3. Focus on the music
4. Engage in deep breathing or progressive muscle relaxation.

> Sokoon offers a selection of relaxing music options or enables users to choose from different genres or styles before embarking on the relaxing mini-game and in the relaxation part as younger individuals may lean toward modern ambient songs, while older demographics may find classical music or nature-inspired sounds are calmer.[36]
>
> At Sokoon, we offer two types of music: Binaural Meditation (MBM) (open source) for younger ages and low-arousal classical music (open source) for older age groups.[36]

The gratitude planet

This planet features three mini-games, including the examples shown in Figure 12, which are designed to help users focus on positive aspects of their lives, such as blessings, family, and good memories. Each game involves collecting a series of flowers using a butterfly. When the butterfly

Figure 6. The badges page. (Design Credits: The researcher).

lands on a flower, a gratitude sentence appears, and the player earns points. To achieve a high score, the player must collect all of the flowers without missing any.

The behavior activation planet

Individuals with depression often experience reduced interest in routine activities and a decreased capacity for pleasure.[37] To address this issue, we have incorporated a simple feature into our app that suggests different activities for the user to try (Figure 13). These suggestions can help users discover new hobbies and interests, potentially improving their mood and overall sense of well-being.

Procedure

We have completed the pre-design phase for our application, which involved identifying our target audience as adults over 18, with a particular focus on university students who may be more susceptible to depression and anxiety due to psychosocial factors.[38] During this phase, we consulted with the psychiatrist to determine the necessary tasks and skills and covered topics such as design, acoustics, visuals, and content creation.

The psychiatrist contributed to the application's development by participating in the selection and validation of skills intended for inclusion in the app. His involvement encompassed reviewing and endorsing the suitability of

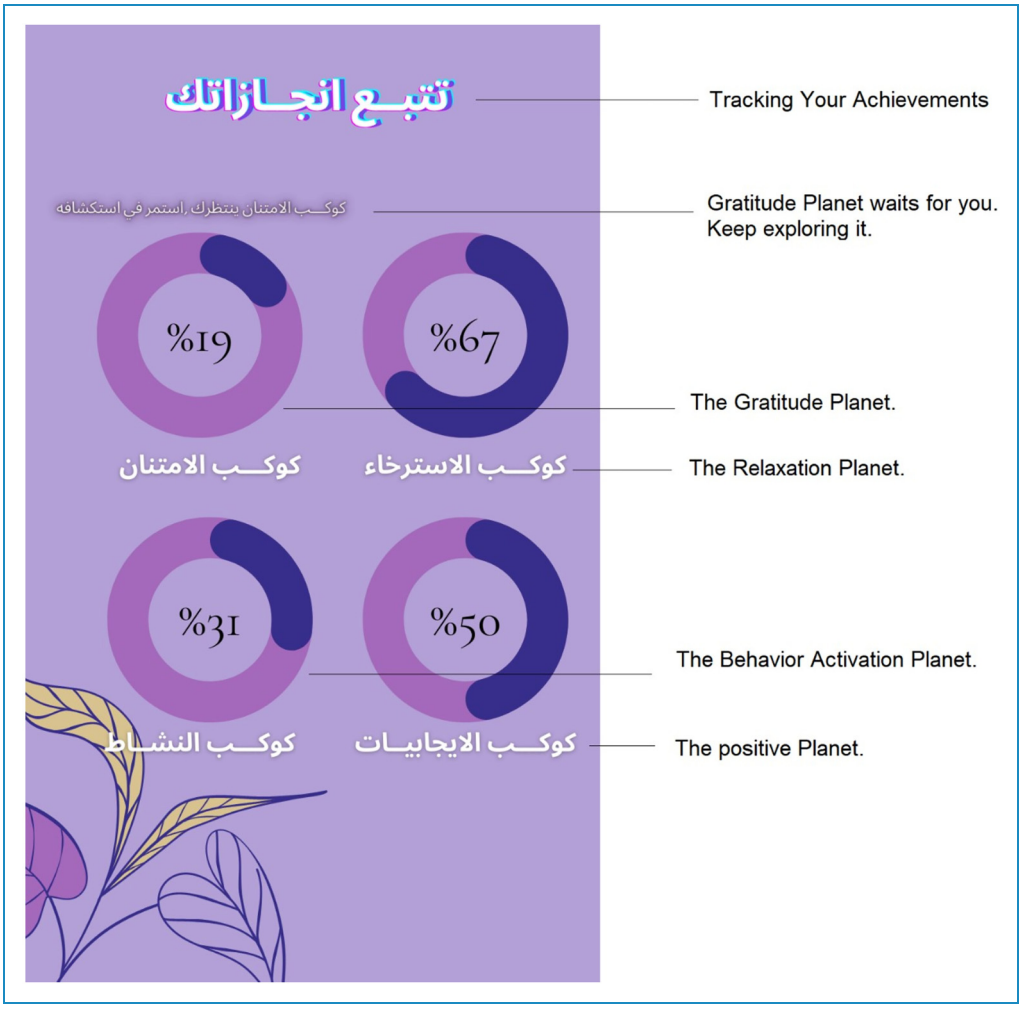

Figure 7. The progress track page (Design Credits: The researcher).

each skill, ensuring alignment with mental health standards, and validating the efficacy of these skills for addressing anxiety and depression.

We also agreed on the name for the app, Sokoon, and developed the main layout, appearance, colors, elements, and delivery method incrementally over several weeks of development.

For colors, a study showed a relationship between blue and safe/comfortable, orange and upset/annoying/annoying, and black and hopeless/depressed and strong.[39] Accordingly, we moved away from black and orange in the design and adopted light colors and light backgrounds as Light or neutral background colors help make the content more visible and readable.[40] High saturation colors were used in a few positions just to attract attention.

The prototype of Sokoon includes four modules: Gratitude, Relaxation, Behavior Activation, and Cognitive Restructuring. To encourage engagement, we have incorporated gamification features, applying the Hexad theory to increase customization for each user's personality type. We have also utilized a DDA algorithm to adaptively change the difficulty level of a game. Our approach involved creating mini-games and exercises as part of an Android mobile application using the gamification features provided by a Unity 2D game engine.[41] Since the Unity engine is cross-platform, porting games to other platforms such as the web, PC, and iOS is easier.

Participants were chosen, and instructed to use the program, received assistance in downloading the app to their smartphone, and then results and feedback were gathered from their providers.

After finishing, the proposed model was then provided to the participants for a two-week trial period, as the psychiatrist overseeing the study recommended. At the end of the trial, results were collected manually via email. The results of 30 participants were analyzed to assess the effectiveness of the proposed model.

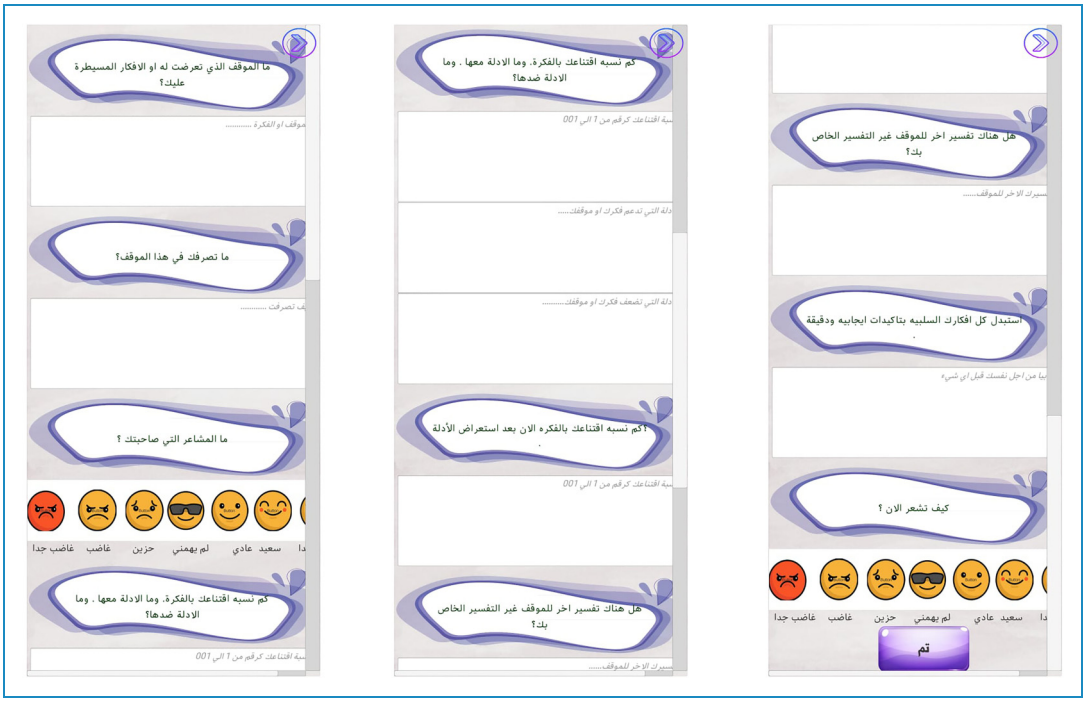

Figure 8. Record thoughts on the positive planet. (Design Credits: The author) (Appendix 1).

Instruments

Depression and anxiety symptoms measurement. The GAD-7 and the PHQ-9 are two extensively used and publicly available assessment instruments that will be used in this study to evaluate changes in depression and anxiety symptoms (DASDs) before and after the intervention. In clinical and research contexts, the PHQ-9 is a validated measure of depression severity that is accurate and brief.[33] Comparably, the seven-item GAD-7 is a widely recognized measure of anxiety levels that has good procedural, factorial, criterion, and conceptual validity.[34]

The gamified user-type test. We employed the gamified user type test to identify users' gaming personalities so that we could customize gamification features based on their individual characteristics. A correlation analysis was performed to verify the framework's validity as a gauge of player preference for different elements of game design. This scale instrument advances the field of game user research by precisely quantifying user preference for gamification.[24]

This test was integrated into the registration process (Figure 1(b)), appearing as the second page after users completed their initial registration steps. Once the registration phase concluded, users were directed to the main page of the application. The Andrzej Marczewski framework,[24] which classifies users inside a gamified system based on their gaming interests and behaviors, is where the gamified user type test used in our study was tailored. The test consists of 24 questions, and each question has seven options, each with a score ranging from strongly agree (3) to strongly disagree (−3). The questions are designed to evaluate the user's personality type in gaming, and they cover a range of topics, such as helping others, trying new things, following rules, being part of a community, mastering complex tasks, and winning prizes. By answering the questions and scoring each option, the user's personality type can be classified into one of several categories, including Philanthropists, Socializers, Free Spirits, Achievers, Players, and Disruptors.

The results of the user type test were derived as follows:

For each user type (Socializer, Philanthropist, Free Sprite, Achiever, Disruptor, Player), identify the four questions associated with that type as Figure 14 shows:

(a) For each question in the Hexad theory test, assign a numerical value ranging from 1 to 7 to each possible answer (1 = strongly disagree, 7 = strongly agree).
(b) For each user, record their response to each question in the Hexad theory test.
(c) For each user type, sum the numerical values of the four questions associated with that type to obtain a total score for that type.
(d) Calculate the sum of the numerical values for all 24 questions in the Hexad theory test to obtain a total score.
(e) For each user type, divide the total score for that type by the total score for all 24 questions and multiply the result by 100 to obtain a percentage score.
(f) Display the percentage score for each user type to the user in the Sokoon application interface (Figure 2).

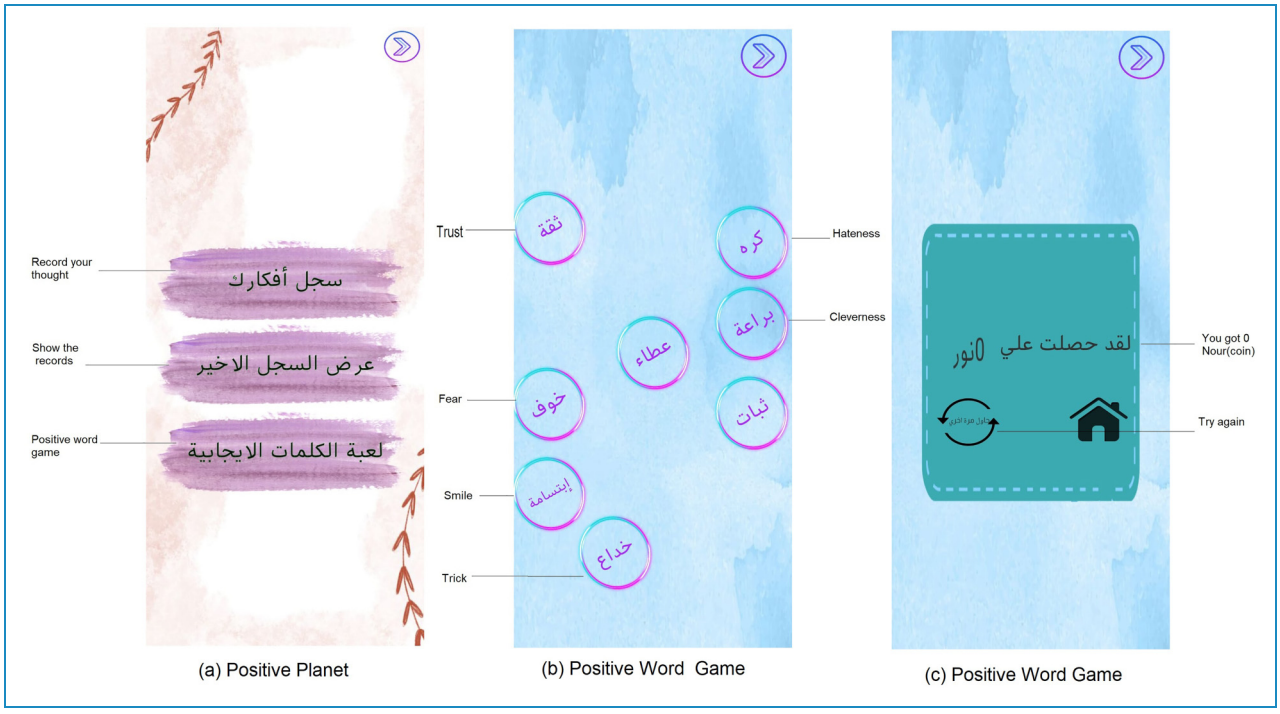

Figure 9. The positive word game. (Design Credits: The author).

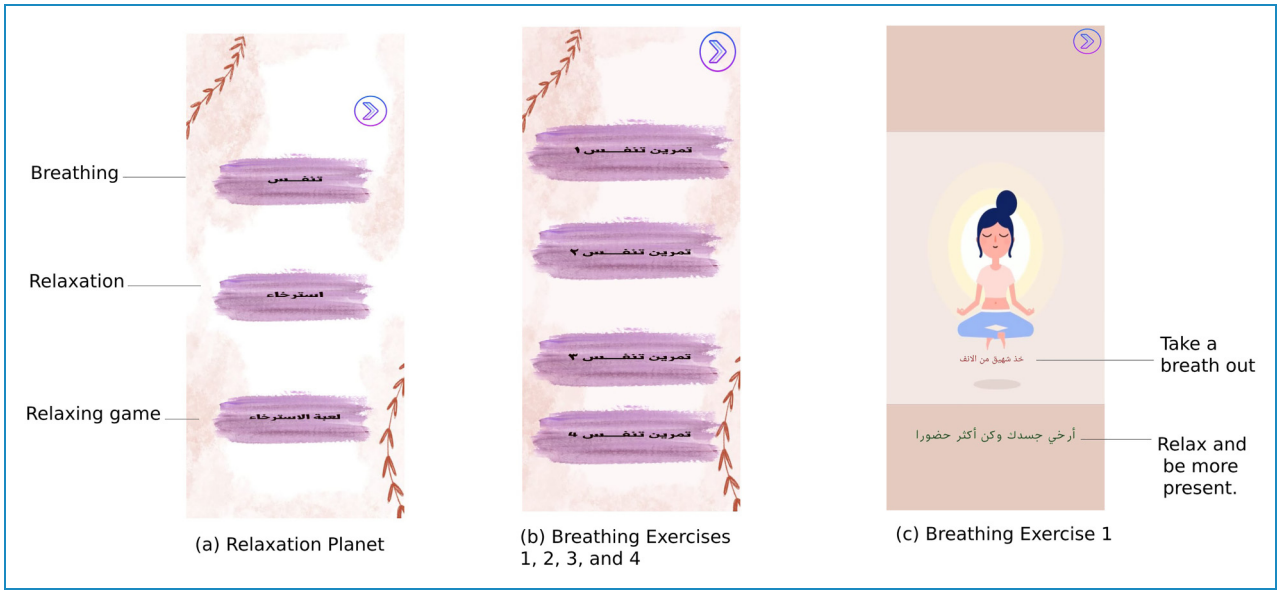

Figure 10. Breathing exercises in the relaxing planet. (Design Credits: The authors).

The usability metrics (based on Nielsen Norman Group). Usability metrics are a set of measurements used to assess the effectiveness, efficiency, and satisfaction of users when interacting with a product.[42] They offer insightful information on how simple and efficient a product is for the people who are supposed to use it.

To measure effectiveness, we calculated the success score. The success score is one of the most often used usability measures. By equation (2), it calculates the proportion of users who finish a task successfully. Success scores provide an overall overview of how well users can use the product to achieve their objectives:

$$Success\ Score = \frac{N\ of\ completed\ task}{total\ N\ of\ Attempts} \quad (2)$$

Another important usability metric is the number of errors. Nielsen suggests two approaches to measuring errors: error

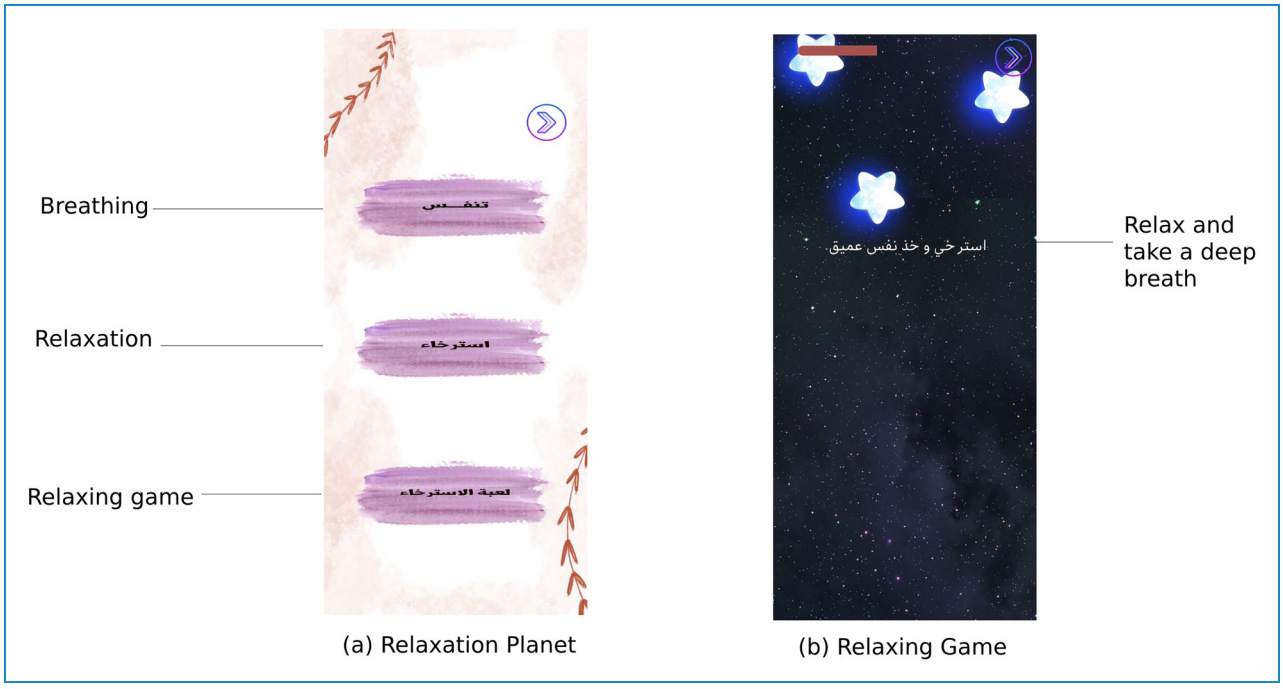

Figure 11. The relaxing game in the relaxation planet. (Design Credits: The authors).

occurrence rate and error rate. The total number of errors divided by the total number of attempts yields the error occurrence rate (equation (3)). This measure tells us how many mistakes a user makes on each try. Through the examination of error occurrence rates, researchers and designers can pinpoint typical obstacles or problems that users have when completing tasks.

If the success rate is zero or the error rate is high, Sokoon provides a motivational message that appears to the user urging him to try again with motivational phrases and also offering constructive guidance when errors occur:

$$error\ occurrence\ rate = \frac{total\ N\ of\ errors}{total\ N\ of\ possible\ errors} \quad (3)$$

Efficiency is another aspect of usability that can be measured using usability metrics (equation (4)). One statistic that is frequently used to evaluate efficiency is task time. It calculates how long it takes users to do an activity. Time-based efficiency is an additional metric for measuring efficiency that combines task time and success score. This statistic gives information on how rapidly users can complete tasks in the product:

$$Time\ based\ efficiency = \frac{\sum_{j=1}^{R}\sum_{i=1}^{N}\frac{nij}{tij}}{NR} \quad (4)$$

where N = The total number of tasks (goals); R = The number of users; n_{ij} = The result of task i by user j; if the user successfully completes the task, then $n_{ij} = 1$, if not, then $n_{ij} = 0$; t_{ij} = The time spent by user j to complete task i. If the task is not completed, then time is measured till the moment the user quits the task.

Satisfaction is a crucial component of user experience, and usability metrics can be used to measure it. Nielsen lists the System Usability Scale and the Single Ease Question (SEQ) as two metrics for measuring customer satisfaction. We used SEQ, which asks users to rate the task's complexity on a subjective basis by answering a single question. Users rate the difficulty on a scale of 1–7, where 1 indicates "very difficult" and 7 denotes "very easy." These metrics reflect how satisfied customers are with the product overall and how easy it is to use.

Data analysis

Means and standard deviations are examples of descriptive statistics, that were calculated to summarize the clinical characteristics of the sample. We employed a paired sample t-test via JASP to analyze the PHQ-9 and GAD-7 scores at both baseline and post-intervention time points. The amount of the intervention impact will be determined using Cohen's *d*-effect size estimates. We used Cohen's guidelines for interpreting effect sizes, where an effect size of 0.2 is considered small, 0.5 is medium, and 0.8 or higher is large.[43] A power analysis showed that a target sample size of 26 was needed to detect a minimal effect size of 0.60 with alpha = .05 and a power of 0.90 for a paired sample t-test.

Figure 12. The gratitude game. (Design Credits: The authors).

Results

Sample characteristics

We recruited a random sample of 30 adults aged between 18 to 35 years (mean age = 24.6 years, SD = 4.9) to participate in the study. Among the participants, 4 were male (13.3%) and 26 were female (86.7%). Regarding education, 50% were pursuing college-level education, while the other 50% had obtained a university degree. In terms of marital status, six participants were married (20%), while the 80% were single. Additionally, all participants reported being in good economic condition.

The usability metrics results

The usability metrics for Task 1 (Registration) and Task 2 were calculated according to the Nielsen Norman Group.[42] For Task 1, the Task Success Rate was 100%, indicating that all users who attempted to register were able to finish the task effectively. The User Satisfaction for Task 1 was 5.3, which is the average satisfaction rating given by users after completing the registration task on a scale of 1–7. The Average Task Time for Task 1 was 2.23 min, which is the average time taken by users to complete the registration task. The Time-Based Efficiency for Task 1 was 52%, which measures the percentage of time users spent actively completing the task as opposed to waiting for the system to respond or load. The Average Error Occurrence Rate for Task 1 was 0.05, which is the average number of errors encountered per user while attempting to complete the registration task.

For Task 2, the Success Score was 81.5, which is a measure of the overall success rate of the task, taking into account both completed and partially completed attempts. The Average Task Time for Task 2 was 1.85 min. The Average Error Occurrence Rate for Task 2 was 0.13. The Time-Based Efficiency for Task 2 was 43%. The Average Satisfaction (SEQ) for Task 2 was 5.7, using the SEQ method. Table 2 summarizes the usability metrics applied.

Overall, the findings show that users were able to complete both activities with high success rates and low error occurrence rates. Additionally, the users were able to finish the jobs quickly based on the low average task times. The Time-Based Efficiency for both jobs, however, was comparatively poor, indicating that consumers had to wait a long time for the system to reply or load. Both exercises had above-average User Satisfaction scores, demonstrating that users were generally happy with their experience performing the assignments.

Depression and anxiety symptoms results

The results showed that Sokoon's participants had a significant reduction in symptoms of depression and anxiety after using the application as shown in Figure 15. With a large effect size ($d = 2.7$, $d = 3.6$) for depression and anxiety based on the PHQ-9 test and GAD-7 test results. From the pretest to the posttest, the participants' anxiety symptoms were less severe (M = 10.9, SD =2.1 vs. M = 5.1,

Figure 13. The behavior activation planet. (Design Credits: The authors).

SD = 2.08), Likewise, their depressed symptoms decreased (pretest: M = 10.9, SD = 2.3; posttest: M = 4.3, SD = 1.7). The outcomes indicated that the intervention had a major effect in reducing anxiety and depression levels ($p < 0.001$).

The gamified user test was used to improve the gamification features of a CBT application designed to promote mental health and well-being. The test was administered during the registration process and used to categorize users into six Hexad types based on their motivation for playing games.

The results of the study showed that gamification features tailored to each Hexad type can improve user engagement, motivation, and retention in the CBT exercises. The majority of users belonged to the "Achiever" and "Philanthropist" user types Figure 15, demonstrating their motivation to utilize the service through collaborative engagement and achievement.

Performance metrics

Based on how well the players performed, the game's difficulty level was modified using the DDA algorithm. The initial level of difficulty was set based on the performance of a reference player who had achieved the target level of performance. The algorithm then adjusted the difficulty level based on the performance of each participant.

Our results showed that the DDA algorithm was effective in adapting the difficulty level of the game to each user's needs and preferences. And resulted in higher levels of motivation, engagement, and satisfaction with the game mechanics and content. We noticed that Participants spend more time in the positive planet mini-game than on other planets. By applying the DDA to our game, we can potentially create a more personalized and engaging experience for our users, which can help to promote learning and skill development. We also found that the users showed improvements in their mental health outcomes throughout the study.

Overall, these results suggest that the Sokoon intervention may be an effective treatment for reducing symptoms of anxiety, and depression but to verify these results and investigate the intervention's long-term consequences, additional study is required.

Discussion

We aimed to evaluate the effectiveness and utility of the Sokoon intervention, which integrates gamification components tailored to each Hexad type, in enhancing user motivation, engagement, and retention during CBT activities. Specifically, our objective was to assess the impact of Sokoon on mental health outcomes by reducing anxiety and depression symptoms in individuals with mild to moderate cases of these disorders.

Mental illnesses such as depression and anxiety have spread widely among adults, and for several reasons, there is no interest in going to a psychiatrist, including that psychological treatment is expensive and requires a lot of time, follow-up, and feelings of shame, which made the problem exacerbate. The mental illness may be in an early stage from mild to moderate, and lack of interest makes it get worse. Sokoon is an app for treating patients with mild to moderate anxiety, and depression based on gamified CBT. This does not mean replacing psychiatrists, but it is a quick and helpful solution. Compared to previous studies that applied CBT and its skills, we added more skills and applied the Hexad theory to make the gamification experience more customized, unlike previous studies that were content with gamification regularly. We also applied a DDA Algorithm to one of the games to make the experience far from boring or difficult. To our knowledge, this is the first study of its kind that applies the Hexad theory and combines DDA with CBT to reduce symptoms of anxiety and depression.

The study's main findings indicate that the Sokoon intervention had a positive effect on user engagement, motivation, and retention in CBT exercises. Users demonstrated successful completion of tasks, reflecting the effectiveness of the intervention. However, there were longer wait times for system replies, resulting in relatively low Time-Based Efficiency. Nonetheless, user satisfaction ratings surpassed the average, indicating overall contentment with the experience.

Furthermore, the study demonstrated that the DDA algorithm, which effectively adjusted the game's difficulty level based on player performance, enhanced player motivation, engagement, and satisfaction. The extended duration of participants' engagement with the Positive Planet mini-game highlighted how DDA could provide engaging and personalized experiences that support skill development and

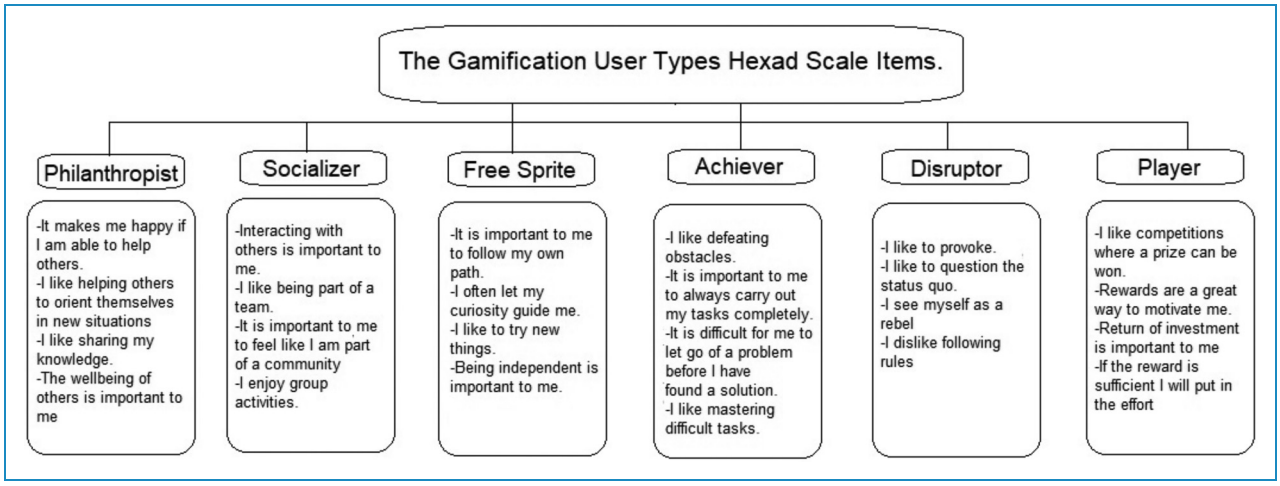

Figure 14. The gamification user types hexad scale items. Adapted from Tondello et al.[25]

Table 2. The usability metrics results (based on nielsen norman group).

Usability Metrics	The First Task (Registration)	The Second Task(Gratitude mini-game)
Effectiveness	100%	81.5%
Average error occurrence rate	.05	.13
Average task time	2.23 min	1.85 min
Time-based efficiency	52% goals/min	43% goals/min
Average Satisfaction (SEQ)	5.3	5.7

learning. Additionally, throughout the trial, the intervention showcased improvements in users' mental health outcomes.

It is possible to achieve success with a single concentration on a gamification feature for a certain user type, especially if it closely corresponds with that user type's interests and motivations. It makes it possible for a more customized and targeted experience, which could improve user retention and engagement with the application. But for a more thorough application of CBT, combining a wide range of gamification components specific to various CBT facets could provide a more successful and well-rounded therapeutic experience for a larger user base.

Comments from volunteers included that they liked the mini- games, the design, the music we used, and the procedure for obtaining prizes and badges. Some also say that using the application helped them improve their mood in real time and loved using it.

Comparison with similar studies

According to Table 3, Sokoon had a significantly larger effect size (Cohen's d) for both depression (2.7) and anxiety (3.6). A value of 0.8 or more is considered a large effect size as mentioned in the methods section. Sokoon surpassed this threshold compared to the other applications listed, including MTPhonix, Sparx, SuperBetter, and mindfulness meditation, which had effect sizes ranging from 0.28 to 1.05 for depression with no study reporting an anxiety effect size.

It's important to note that there were only a small number of studies included in this comparison because unavailability of similar studies with effect size results and that effect sizes may vary depending on the specific intervention and population studied. However, the results suggest that Sokoon use of a DDA algorithm may have contributed to its larger effect sizes compared to other gamified interventions for depression and anxiety.

Limitations and future work

During the testing procedure, Sokoon's drawbacks were discovered. Our system only supports the Arabic language, as we took care of introducing it to Arab countries. Future versions can add more languages to make the app widely used.

Because this study uses a single-group pre–post design, there is a lack of a control group. In future research, a randomized controlled trial with a control group could be used to further investigate the effectiveness of this intervention.

Not all gamification elements have been applied due to the difficulty of applying them, such as leaderboards, sharing to social media, teams, and others. By including these components in the future, we hope to improve the platform's socializing potential and foster a sense of

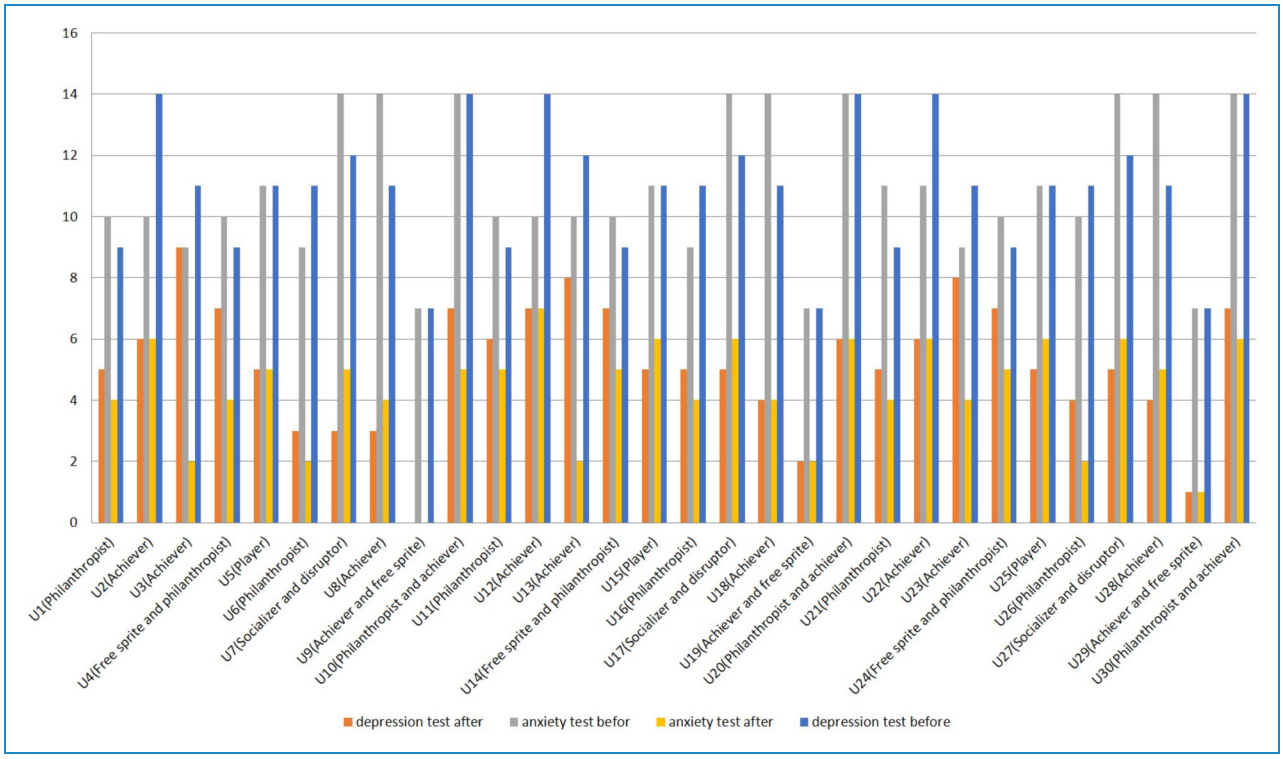

Figure 15. The outcome of the depression and anxiety tests conducted before and after the use of sokoon as well as the gamified user type test results.

community among users. As a prototype, we did not activate all the CBT skills that we mentioned, and there were a few games. Future versions can activate all the skills, which increases the improvement of cases and gives the experience a lot of pleasure, adds more games that make the experiment more fun, and enhances the platform with interactive workouts and engaging stories.

As the application includes some but not all components of evidence-based CBT, it cannot be independently relied upon to effectively recover from depression and anxiety. In the future, we can further enhance the application by incorporating additional CBT skills and techniques.

The sample used was close in age, and most of them were female. In the future, it is possible to apply it to a larger sample with more different age groups. A larger sample size would be needed to confirm the findings of this study and to generalize the results to the larger population.

While our DDA algorithm was effective in adapting the difficulty level of the game based on the user's performance and preferences, there is still room for improvement. Future research could explore more advanced algorithms, such as deep reinforcement learning, to learn more complex and nuanced patterns in the user's behavior and provide a more personalized and adaptive experience.

The psychiatrist can be involved in the application, where patients who want more treatment can communicate and follow up with the psychiatrist. The psychiatrist can follow the patient's page to see the progress in his psychological condition.

We intend to extend our feedback process in the future to incorporate other techniques for gathering user insights. To better understand user experiences and preferences when using the program, this may involve methods such as surveys, in-depth interviews, observation, or other methods. Our goal in implementing these techniques is to collect more thorough and insightful input to guide the application's continuous improvement and development.

Despite these drawbacks, the study will still help discover more about the possible advantages of Sokoon for treating people's symptoms of anxiety and depression.

Conclusions

This paper's objective is to review the supporting data for the efficacy of CBT in treating DASDs and to explore the potential for gamifying CBT to enhance its efficacy. We describe the approach we have taken in designing Sokoon, a mobile application that applies CBT skills as a set of planets and uses gamification to increase adult engagement and applies hexad theory to increase

Table 3. Comparison of effect sizes in interventions using gamification and DDA: Sokoon vs. other applications.

The study	Year	Target mental health	Intervention length	*N*	Cohen's *d* (Effect size)		DDA	Gamification
					Depression	Anxiety		
Sokoon	2023	Depression and anxiety	2 weeks	30	2.7	3.6	✓	✓
MTPhonix [19]	2019	depression	2 weeks	77	1.02	N/A	×	✓
Sparx [20]	2020	depression	4 weeks	50	.6	N/A	×	✓
mindfulness meditation [15]	2019	depression	2 weeks	72 (33 experimental group)	.28	N/A	×	✓
SuperBetter[44]	2015	depression	4 weeks, measured every 2 weeks	283	.67 (posttest) 1.05 (follow up)	N/A	×	✓

customization with DDA to help adults with DASDs. Gamifying CBT appears to increase engagement and motivation, and to reduce the time and cost of treatment. Gamified CBT interventions that target hexad theory may be more effective than traditional CBT interventions. Hexad theory provides a framework for understanding how game elements can be used to motivate people. When combined with CBT, gamification can be used to improve engagement with the treatment and to accelerate the treatment process. This event could lead to greater adherence to CBT, more effective treatment outcomes, and improved quality of life for people suffering from depression and anxiety. By harnessing the power of gamification and the hexad theory, CBT can be used more effectively to help people overcome these barriers and live healthier lives.

The assessment of this application's utilization by adults indicated that its interface resembled other applications familiar to our target users, enhancing its usability, and the application showed effective results in improving the psychological state of adults after using the application, which was determined by the depression and anxiety scale (PHQ-9, GAD-7) before and after using the application. We also used usability metrics to assess the efficiency, effectiveness, and satisfaction of adults who used the app. This show how easy and effective the app is for users as the results show. Outside of scheduled therapy sessions, Sokoon expanded access to evidence-based CBT techniques in a format that was well-liked and utilized by adults. We used several techniques we thought would result in a better outcome such as Hexad theory, gamification, and DDA. To create a more engaging experience, we used the Hexad theory for personalizing gamified systems to users' personalities. This added a type of customization for each user, as the appropriate gamification elements were selected for each user's personality.

The usefulness of Sokoon should also be investigated for additional outcomes, such as suicidal ideation, and in understudied populations, such as older persons. Further research is needed to investigate the mechanisms by which gamification enhances CBT for depression and anxiety and to develop and test more effective gamified CBT interventions. It is anticipated that this technology will advance in the next years, making it easier for people to obtain therapies in the manner that most suits them.

In conclusion, our study has provided a foundation for future research and development in gamified CBT applications using DDA and other advanced algorithms. We hope that our findings will inspire further exploration and innovation in this field to improve the mental health outcomes of individuals suffering from depression and anxiety.

Acknowledgments: The authors extend our sincere gratitude to Psychiatric Omar Adel for his invaluable guidance and support throughout. His expertise and insights significantly contributed to the development of this research.

Contributorship: All authors contributed to the conception and design of the study. All authors reviewed and approved the final version of the manuscript.

Declaration of conflicting interests: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval: Before beginning the study, each participant gave their written informed consent, and the confidentiality of their information was scrupulously respected at all times.

Funding: The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the National Research Foundation of Korea, (grant number RS-2023-00218176).

Guarantor: NAA.

ORCID iDs: Nourhan A. Amer https://orcid.org/0000-0003-3783-8627
Waleed Eladrosy https://orcid.org/0000-0001-7053-0275

References

1. Gamm L, Stone S and Pittman S. Mental health and mental disorders_a rural challenge: a literature review. *Rural Health People* 2010; 1: 97–114.
2. Alshawwa A, Elkahlout M, Qasim El-Mashharawi H, et al. An expert system for depression diagnosis. *Int J Acad Health Med Res* 2019; 3: 20–27.
3. World Health Organization. *Anxiety disorders*. Geneva, Switzerland: World Health Organization. https://www.who.int/news-room/fact-sheets/detail/anxiety-disorders#:~:text=An%20estimated%204%25%20of%20the (2023, accessed 20 April 2024).
4. Sancakoğlu S and Sayar K. Relation between socioeconomic status and depression, anxiety, and self-esteem in early adolescents. *Yeni Symposium* 2012; 50: 207–220.
5. Brenes GA. Anxiety, depression, and quality of life in primary care patients. *Prim Care Comp J Clin Psyc* 2007; 09: 437–443.
6. Williams C and Chellingsworth M. *CBT: A clinician's guide to using the five areas approach*. London: CRC Press, 2010.
7. Kaltenthaler E, Brazier J, De Nigris E, et al. Computerised cognitive behaviour therapy for depression and anxiety update: a systematic review and economic evaluation. *Health Technol Assess* 2006; 10: 1–186.
8. So M, Yamaguchi S, Hashimoto S, et al. Is computerised CBT really helpful for adult depression?—A meta-analytic re-evaluation of CCBT for adult depression in terms of clinical implementation and methodological validity. *BMC Psychiatry* 2013; 13: 1–14.
9. Vallury KD, Jones M and Oosterbroek C. Computerized cognitive behavior therapy for anxiety and depression in rural areas: a systematic review. *J Med Internet Res* 2015; 17: e139.
10. Miloff A, Marklund A and Carlbring P. The challenger app for social anxiety disorder: new advances in mobile psychological treatment. *Internet Interv* 2015; 2: 382–391.
11. Deterding S, Dixon D, Khaled R, et al. From game design elements to gamefulness. In *Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek* 2011; 11: 9–15.
12. Damaševičius R, Maskeliūnas R and Blažauskas T. Serious games and gamification in healthcare: a meta-review. *Information* 2023; 14: 105.
13. Sinha N. Introducing gamification for advancing current mental healthcare and treatment practices. *IoT Healthc Ambient Assist Living* 2021; 933: 223–241.
14. Six SG, Byrne KA, Tibbett TP, et al. Examining the effectiveness of gamification in mental health applications for depression: a systematic review and meta-analysis (preprint). *JMIR Ment Health* 2021; 8: e32199.
15. Fish MT and Saul AD. The gamification of meditation: a randomized-controlled study of a prescribed Mobile mindfulness meditation application in reducing college students' depression. *Simul Gaming* 2019; 50: 419–435.
16. Christie GI, Shepherd M, Merry SN, et al. Gamifying CBT to deliver emotional health treatment to young people on smartphones. *Internet Interv* 2019; 18: 100286.
17. Bakker D, Kazantzis N, Rickwood D, et al. Mental health smartphone apps: review and evidence-based recommendations for future developments. *JMIR Ment Health* 2016; 3: e7.
18. Litvin S, Saunders R, Maier MA, et al. Gamification as an approach to improve resilience and reduce attrition in mobile mental health interventions: a randomized controlled trial. *PLoS ONE* 2020; 15: e0237220.
19. Lukas CA, Eskofier B and Berking M. A Gamified smartphone-based intervention for depression: randomized controlled pilot trial. (Preprint). *JMIR Ment Health* 2019; 8: e16643.
20. Yokomitsu K, Irie T, Sekiguchi M, et al. Gamified mobile computerized cognitive behavioral therapy for Japanese university students with depressive symptoms: protocol for a randomized controlled trial. *JMIR Res Protoc* 2020; 9: e15164.
21. Patterson VC, Rossi MA, Pencer A, et al. Tranquility: an adaptation co-design and fidelity evaluation of an internet-based cognitive-behavioural therapy (iCBT) program for anxiety and depression (Preprint). *JMIR Format Res* 2021; 6: e33374.
22. Dias LPS, Barbosa JLV, Feijó LP, et al. Development and testing of iAware model for ubiquitous care of patients with symptoms of stress, anxiety and depression. *Comput Methods Programs Biomed* 2020; 187: 105113.
23. Krath J and von Korflesch HFO. Player types and game element preferences: investigating the relationship with the gamification user types HEXAD scale. *Lect Notes Comput Sci* 2021; 12789: 219–238.
24. Marczewski A. *Even Ninja Monkeys Like to Play: Gamification, game thinking and motivational design*. illustrated. CreateSpace Independent Publishing Platform, 2015.
25. Tondello GF, Wehbe RR, Diamond L, et al. The gamification user types hexad scale. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play* 2016: 229–243.
26. Jamaludin NF, Tengku Wook TSM, Mat Noor SF, et al. Gamification design elements to enhance adolescent motivation in diagnosing depression. *Int J Int Mobile Technol* 2021; 15: 154.
27. Sepulveda GK, Besoain F and Barriga NA. Exploring dynamic difficulty adjustment in videogames. In *2019 IEEE CHILEAN Conference on Electrical, Electronics Engineering, Information and Communication Technologies (CHILECON)* 2019: 1–6.
28. Zohaib M. Dynamic difficulty adjustment (DDA) in computer games: a review. *Adv Hum-Comput Interact* 2018; 2018: 1–12.
29. Otis JD. *Managing chronic pain: A cognitive-behavioral therapy approach: Workbook*. Oxford: Oxford University Press, 2007.
30. Booth M. The AI systems of left 4 dead. *Artif Intell Interac Digital Entert Conf Stanford* 2009.
31. Robb N and Zhang B. Performance-based dynamic difficulty adjustment and player experience in a 2D digital game: a controlled experiment. *Acta Ludologica* 2022; 5: 4–22.

32. Amer NA, Shohieb SM, Eladrosy WM, et al. Sokoon. *Int J Gam Comp-Med Sim* 2023; 15: 1–26.
33. Kroenke K, Spitzer RL and Williams JBW. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med* 2001; 16: 606–613.
34. Spitzer RL, Kroenke K, Williams JBW, et al. A brief measure for assessing generalized anxiety disorder. *Arch Intern Med* 2006; 166: 1092–1097.
35. Nezu CM and Nezu AM. *The Oxford handbook of cognitive and behavioral therapies*. New York, NY: Oxford University Press, 2016.
36. Lee-Harris G, Timmers R, Humberstone N, et al. Music for relaxation: a comparison across two age groups. *J Music Ther* 2018; 55: 439–462.
37. Szyguła-Jurkiewicz B, Duszańska A and Poloński L. Is depression a problem in patients with chronic heart failure? *Polish Arch Int Med* 2008; 118: 52–56.
38. Farrer LM, Gulliver A, Bennett K, et al. Demographic and psychosocial predictors of major depression and generalised anxiety disorder in Australian university students. *BMC Psychiatry* 2016; 16: 1–9.
39. Wexner LB. The degree to which colors (hues) are associated with mood-tones. *J Appl Psychol* 1954; 38: 432–435.
40. *How to Choose the Best Colors For The User Interface?* GeeksforGeeks, https://www.geeksforgeeks.org/how-to-choose-the-best-colors-for-the-user-interface/ (2020, accessed 20 April 2024).
41. *Download Unity!*. Unity, https://unity3d.com/get-unity/download (2019, accessed 20 April 2024).
42. *7 Essential Usability Metrics and How to Use Them*. www.eleken.co, https://www.eleken.co/blog-posts/usability-metrics (2023, accessed 20 April 2024).
43. Sullivan GM and Feinn R. Using effect size—or why the P value is not enough. *J Grad Med Educ* 2012; 4: 279–282.
44. Roepke AM, Jaffee SR, Riffle OM, et al. Randomized controlled trial of SuperBetter, a smartphone-based/internet-based self-help tool to reduce depressive symptoms. *Games Health J* 2015; 4: 235–246.

Appendix 1

The steps of recording thoughts on the positive planet.

1. What situation have you been exposed to or the idea controlling you?
2. What do you do in this situation?
3. What are the feelings that accompanied you?
4. Rate the intensity of your feelings from 1 to 10.
5. How much do you believe in the idea? And what is the evidence behind it? What is the evidence against it?
6. After reviewing the evidence, how much do you believe in the idea?
7. Is there another explanation for the situation other than your own?
8. Replace all your negative thoughts with positive, accurate affirmations.
9. How are you feeling now? Rate your feelings from 1 to 10.