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Designing a Scalable, Accessible, and Effective Mobile App Based Solution for Common Mental Health Problems

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ABSTRACT

The need for treatment of common mental health problems such as depression or anxiety has steadily increased. However, many people still do not receive effective and timely treatment due to the low availability, accessibility, and acceptability of traditional counseling. In this study, we developed a scalable, effective, and accessible app to address the problems that arise in traditional face-to-face counseling and to treat common psychological problems such as mild depression that people experience in their daily lives. The suggested app features semi-crowdsourced counseling, immediate intervention from multiple counselors, Cognitive Behavioral Therapy (CBT)-based short comments, and gamification. In a two-week randomized control trial (RCT), we surveyed 47 college students in their 20 s to investigate the efficacy of the suggested app and found that depression levels were reduced significantly only in the experimental group using the app. In addition, we conducted a user survey to determine which design factors affected the user experience of clients and counselors using the app. The proposed app can be used to help those suffering from mild depression in daily life, and it can also be used as a training aid to enhance counselors' counseling skills.

1. Introduction

The need for treatment of common mental health problems such as depression or anxiety has steadily increased (World Health Organization, 2017). In particular, reports have indicated that, in addition to the prevalence of such problems among adults, 20% of children under the age of 18 have diagnosable mental health problems (Green et al., 2005; Merikangas et al., 2010). Receiving timely treatment is crucial because mental health problems that go untreated in childhood can continue into adulthood and contribute to serious mental problems (Woodward & Fergusson, 2001). These mental problems have a negative impact on individuals' social relationships and physical health (Davies, 2014); moreover, expenditures on mental health such as depression and anxiety in the US carry high social costs (Rice & Miller, 1998).

However, due to the low availability, accessibility, and acceptability of traditional counseling methods, many adults and children do not receive effective and timely treatment (Chen & Hou, 2002; Demyttenaere et al., 2004; Merikangas et al., 2010). First of all, the problem of availability arises from the mismatch in the number of people who need psychological counseling and the number of counselors who can provide counseling, creating considerable waiting times for those in need of counseling and thereby preventing clients from receiving the immediate treatment they need to deal with their problems (Lovell & Richards, 2000; Steinman et al., 2015). Moreover, the high caseloads for counselors that result from this mismatch may prevent counselors from providing qualified counseling (Lovell & Richards, 2000). Second, the problem of accessibility resulting from the high cost of psychological counseling and geographical conditions has driven many people who lack sufficient financial resources or do not live in big cities into a blind spot in psychological counseling (Kessler et al., 2001). In this paper, we use *accessibility* as the term that refers to unmet mental healthcare needs due to high costs or transportation problems, as defined in (Chen & Hou, 2002), rather than accessibility of services including people with disabilities. Lastly, the problem of acceptability, which manifests in social stigmatization and low social acceptance of people with mental problems, makes people fear psychological counseling (Chen & Hou, 2002).

In this paper, we set out to solve the above three problems associated with traditional counseling by proposing the design of a novel mobile application (app) that is scalable, accessible, and effective for treating common psychological problems such as mild depression experienced in daily life. The proposed app features semi-crowdsourced counseling, immediate interventions from multiple counselors, Cognitive Behavioral Therapy (CBT)-based short commentary counseling, and gamification. The app was designed by considering user experience (UX) factors of availability, accessibility, acceptability, usability, desirability, usability, and reward. In the two-week Randomized Control Trial (RCT) to investigate the efficacy of the proposed app, depression was reduced significantly only in the experimental group using the app. In addition, we administered online questionnaires to clients and counselors to investigate which design factors affected their user experience with the app. The proposed app can be

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used to help those suffering from mental health problems such as mild depression in daily life and also as a training aid to enhance counseling skills for counselors.

2. Related work

Researchers have investigated mobile mental health apps as an alternative to traditional psychological counseling, which suffers from low levels of availability, accessibility, and acceptability. The majority of successful mobile mental health apps are based on the CBT theory.

2.1. Mobile mental health care

Smartphones can be used in a variety of ways to benefit both clients and counselors in the field of mental healthcare (Gravenhorst et al., 2015; Luxton et al., 2011; Martínez-Pérez et al., 2013). The most common features that mental healthcare apps provide are related to self-management; such functions help clients manage their symptoms independently by enabling them to self-monitor the problems they experience such as anxiety, depression, drug use, or sleep-deprivation. Mobile mental health apps can also help clients reach out to counselors immediately when they encounter problems and facilitate effective counseling by sharing the data accumulated via continuous self-monitoring and assessment with the counselors (Bardram et al., 2013). In addition, since they have text-, audio-, and video-related functions, mobile mental health apps can assist clients and counselors in self-training. Clients can become more capable of dealing with their symptoms by acquiring information about their symptoms and training themselves to manage them. For example, the *PTSD Coach* app (Kuhn et al., 2014) provides information about post-traumatic stress disorder (PTSD) and suggests CBT-based strategies for dealing with PTSD. *Psych Central*, meanwhile, facilitates counselors' self-development by organizing and providing up-to-date behavioral health research results (Luxton et al., 2011).

Furthermore, smartphones can be used as counseling tools between clients and counselors. Smartphones are often used to provide counselors with counseling synchronously or asynchronously via text, audio, or video for clients who have difficulty visiting counselors due to time, location constraints, or fear of identity exposure. Such mobile therapy can be classified according to the degree of contact between clients and counselors. Simon and Ludman (2009) classified mobile psychotherapy into three categories: (1) high level of contact between clients and counselors (e.g. real-time conversations via audio or video), (2) low level of contact between clients and counselors (e.g. asynchronous dialogue through text messages), and (3) non-contact between clients and counselors (e.g. self-help programs without counselor intervention). However, psychotherapy with high levels of contact carry high costs, placing significant financial burdens on clients.

A variety of meta-analyses and reviews have reported that mental health apps positively affect the treatment of psychological health problems such as depression, anxiety, and bipolar disorder like conventional psychotherapy (Firth et al., 2017a; Firth et al., 2017b; Sucala et al., 2017). In particular, the meta-analyses concluded that the mobile psychotherapy is effective in reducing depression and controlling anxiety (Firth et al., 2017a; Firth et al., 2017b). In addition, Firth and Torous (2015) reported that smartphone-based intervention can assist in the care of patients with schizophrenia with high user engagement in the treatment.

Such smartphone-based mobile mental healthcare has a variety of advantages over conventional face-to-face psychotherapy (Price et al., 2014). Smartphones help clients quickly find counselors with the training to treat their symptoms and they also help counselors intervene quickly when clients have problems. In addition, the use of mobile devices has the great advantage that it enables clients to get help from counselors anytime and anywhere. Finally, since mobile counseling does not occur face-to-face, it is possible to receive anonymous counseling, which can be helpful for many people who have not pursued counseling because they are afraid of the related social stigma. Furthermore, mobile app-based mental healthcare can help achieve equity in treatment because it can provide the same quality of treatment at a low cost even in less resource-intensive areas, enabling users to manage their mental health based on their needs and preferences (Olff, 2015).

The usability of mental health apps has a significant impact on engagement and satisfaction with apps and is, therefore, an important factor in determining the adoption of apps by users (Price et al., 2014). Low usability is a major obstacle to the adoption of many health-related technologies by consumers. In particular, users tend to avoid technologies that they perceive as difficult to use or irrelevant to their needs (Chiu & Eysenbach, 2010). The major usability limitations of mobile devices arise from the small sizes of their screens. A limited amount of information display and slow or error-prone text input due to a small screen keyboard are major limitations that must be overcome to ensure usability. On the other hand, recently gamification has attracted attention as a key element of UX design since it can increase users' engagement with and adherence to apps. Gamification helps users stimulate their internal motivation via rewards, quantifying and tracking their progress toward achieving goals and enabling them to assess their own competency independently (Bakker, Kazantzis, Rickwood & Rickard, 2016).

2.2. Cognitive behavioral therapy (CBT) based apps

CBT is among the most extensively studied and proven psychotherapies, and many previous studies have shown that CBT is an effective treatment for a variety of psychological problems including depression, anxiety, panic disorder, social phobia, obsessive-compulsive disorders (OCD), anger, PTSD, and schizophrenia (Butler et al., 2006; Hofmann et al., 2012). In particular, CBT is highly effective in treating anxiety and depression and is known as the first-line treatment for the symptoms of these conditions. Indeed, in a meta-analysis of RCT studies, Hofmann and Smits (2008) concluded that CBT was a highly effective treatment for anxiety, while research has also shown that CBT is a more effective treatment than interpersonal therapy, psychodynamic therapy, or supportive therapy for depression (Churchill et al., 2002).

Thus, many CBT-based mobile mental health apps have been proposed. For example, Birney et al. proposed the *MoodHacker* app based on Positive Psychology Theory and CBT (Birney et al., 2016). *MoodHacker* is one of the few clinically proven apps for CBT-based self-management of depression. Clients who used the app for six weeks not only alleviated psychological problems such as depression and negative thoughts but also experienced positive changes in their work lives, such as increased productivity. In addition, Fitzpatrick et al. (2017) proposed the *Woebot*, a CBT-based, interactive-conversational agent designed to increase clients' adherence and symptom relief. *Woebot* is based on Artificial Intelligence (AI) technology, enabling clients to have text-based conversations with AI counselors. *Woebot* represents a new way of delivering CBT content, including functions designed to recognize clients' contexts and moods, react empathetically based on clients' moods, and help improve clients' moods by providing access to CBT-based text, audio, and video. The study found that *Woebot* was effective in treating clients' depression and anxiety in a two-week experiment. Another way to improve the engagement of CBT-based therapies is to use peer-to-peer platforms. Morris et al. (2015) proposed a web-based peer-to-peer platform, *Panoply*, designed to facilitate users' cognitive reappraisal. *Panoply* has a crowdsourcing function that allows other users to provide immediate reappraisal support when users post their stressful situations. *Panoply* significantly reduced users' depression in a three-week experiment. In the experiment, the app received higher re-appraisal, user activity, and user experience ratings than an expressive writing group. Many CBT-based apps provide features that suggest activities for diversion, facilitate self-monitoring, and provide CBT-related text/audio/video information. Among the various features on these apps, the feature that helps users cope with negative automatic thoughts is common to most apps (Stawarz et al., 2018).

Despite the fact that the number of mobile mental health apps is growing rapidly because of the high demand and the convenience of mobile devices, Huguet et al. (2016)'s study shows that most of the apps on the market do not properly apply the CBT principles, or that most of the apps have not verified the efficacy. In addition, several recent meta-studies have reported that the evidence supporting the efficacy of CBT-based mobile intervention still remains scarce (Grist et al., 2017; Hollis et al., 2017; Rathbone et al., 2017). Furthermore, there is also a lack of research on which UX design elements of an app affect the user experience (Stawarz et al., 2018).

The mobile app *Spring* proposed in this study shares the main characteristic with *Panoply* in terms of using crowdsourcing to enhance user engagement and provide cognitive reappraisal. However, unlike *Panoply*, the reappraisal of user thoughts in *Spring* is done by a group of counselors who have received formal CBT training. Therefore, any person who has completed CBT-related training at a formal educational institution is qualified and can participate as a counselor. We attempted to solve the problem of availability of traditional psychotherapy due to the lack of professional counselors by requiring counselors only to complete formal CBT training as opposed to requiring them to be fully certified professional counselors. At the same time, we also attempted to ensure the quality of counseling by not letting a person without formal training as a counselor in the app. In addition to as a tool to help alleviate clients' mental health problems, *Spring* is also intended to be used as a self-development tool for counselors.

This study extends the evidence base of the efficacy of CBT-based mobile intervention, particularly cognitive reappraisal based on peer-to-peer interaction, for adults with mild depression through RCT, and also suggest guidelines for the future development of mobile mental health apps by investigating the effect of each UX design factor on both clients and counselors.

3. *Spring*: A semi-crowdsourced cognitive reappraisal mobile application

Spring is a cognitive reappraisal mobile app designed to help people with common mental health problems such as mild depression or anxiety to deal with their symptoms by posting their emotions, situations, and thoughts and receiving advice for cognitive reappraisal from multiple counselors with immediate short comments. It is a semi-crowdsourced app, which means that not everyone, but individuals with certain qualification can contribute to the problem solving. *Spring* aims to overcome the problems of availability, accessibility, and acceptability of traditional face-to-face counseling so that the general public can receive effective and timely help with the common psychological problems.

3.1. Requirements

Spring's design takes both clients and counselors into account. To design the app for clients, we first derived client requirements and divided them into six categories: availability, accessibility, acceptability, usability, desirability, and usefulness (Table 1). In terms of availability, clients want to have counseling promptly (within 24 hours) when they need to deal with their psychological problems such as depression or anxiety with appropriate counselors for their own problems. In terms of accessibility, clients want to consult with counselors whenever and wherever they need without financial burdens. In terms of acceptability, clients want to avoid counseling-related social stigmas by having their anonymity guaranteed. In terms of usability and desirability, clients want to feel at ease and emotionally satisfied in the process of posting about their psychological problems and observing others' posts. Finally, in terms of usefulness, clients want the app to actually solve their psychological problems.

To design the app for counselors, we derived counselor requirements and divided them into four categories: reward, accessibility, usability, and usefulness (Table 1). The requirement that received the greatest emphasis was reward; counselors want to receive appropriate rewards for their counseling services to ensure that they are motivated to help clients in need. In terms of accessibility, counselors want to be able to provide consultations in the times and locations of their choosing. In terms of usability, counselors want app-based

Table 1. User requirements and *spring* features.

Client		Counselor	
Requirements	*Spring* Features	Requirements	*Spring* Features
Accessibility: Clients want to have a counseling 1) without financial burden, and 2) without limitations of time and space.	ACC-COS: Cost-free ACC-ANY: Counseling at anytime and anyplace that clients want through a mobile app, not via an office visit	Accessibility: Counselors want to provide counseling without having to be in their offices at an appointed time	ACC-ANY: Counseling at anytime and anyplace that counselors want in a mobile app environment, not the office
Acceptability: Clients want to avoid social stigma in counseling and want to be guaranteed anonymity.	ACP-ANO: Counseling via anonymous writing	Usability: Counselors want the app-based consultation to be easy and effective.	USA-COM: Counseling via simplified comments. USA-CBT: Receiving clients' posts organized in 3 stages: mood, situation, and thoughts.
Availability: Clients want to receive counseling when they need help 1) promptly (within 24 hours) and 2) with counselors who have appropriate expertise to address their problems.	AVA-IMM: Response to client within 24-hrs by sending push-alarms to increasingly large number of counselors until at least two counselors intervene. AVA-MUL: Counseling through comments from multiple counselors rather than one.		USA-AGE: Providing clients' age and gender information. USA-TIM: Providing clients' posting time USA-DIS: Providing distance information between clients and counselors.
Usability: Clients want the app to be easy to use.	USA-SWI: Showing posts from others via swipe interaction. USA-EXP: Simplifying the process of indicating mood.	Usefulness: Counselors want to self-assess by browsing their past counseling history	USE-ARC: Browsing counselors' past counseling history by themselves.
Desirability: Clients want to be satisfied with the overall emotional experience when using the app.	DES-IMA: Uploading posts in a card format with a background image tailored to clients' preferences.	Rewards: Counselors want to receive appropriate rewards for the counseling they provide.	REW-SPR: Earning and storing a sprout as a reward for providing counseling comments that clients adopt.
Usefulness: Clients want the app to actually help with psychological problems.	USE-CBT: Posting via 3 stages of mood-situation-thinking based on CBT. USE-OTH: Reviewing real-time updated anonymous counseling posts of others to broaden their perspectives. USE-ARC: Archiving and visualizing past moods and posts.		

counseling to be less time-consuming and to receive access to clients' information – including basic details and status – organized in a certain format to ensure effective counseling. In terms of usefulness, counselors want to be able to check counseling history so they can self-evaluate their counseling skills.

3.2. UX designs

We designed the app to satisfy the requirements for both clients and counselors as shown in Table 1. In the following section, we describe four most important features of the app and two major user usage processes of the app.

3.2.1. Features

3.2.1.1. Crowdsourcing counselors. The number of clients in need of traditional counseling far exceeds the number of available counselors. People seeking help with psychological problems commonly have to wait from several days to a few weeks to receive actual help. This imbalance in supply and demand for psychological care is an old issue and is unlikely to improve in the near future due to the fact that the number of counselors who can be trained annually in the limited number of institutions is fixed and becoming a qualified counselor requires years of education. In this study, we focused on mild depression or anxiety problems experienced in daily life and tried to solve the availability problem by expanding the pool of qualified counselors. More specifically, the app minimizes counselor qualifications, allowing any users who have received formal CBT-related training to serve as counselors and thereby enabling more users to act as counselors.

3.2.1.2. Immediate multiple interventions. We designed the app to enable counselors to intervene within 24 hours when clients submit posts seeking psychological help. To accomplish this, we outfitted the app with a push alarm that increases the number of notified counselors gradually by sending the alarm until it reaches at least two counselors capable of intervening. Counselors receive the push alarms based on their geographical proximity to the clients, with alarms first being sent to nearby counselors and then gradually being sent to more distant counselors as time passes in a manner similar to the order in which vehicles are called in vehicle-sharing services (e.g. Uber). This process is based on the assumption that counselors who live closer to clients may have greater cultural and social understanding of the clients than counselors who live in more distant locales.

Traditional counseling is conducted with a single counselor, which makes it difficult for clients with unsuitable counselors to receive effective counseling. Therefore, we designed the app to enable client posts to receive responses from at least two counselors, thereby ensuring that clients receive more help with their psychological problems based on more diverse approaches. The efficacy of the psychotherapy by multiple counselors has been reported in various previous studies. Piaget and Serber (1970) reported the effectiveness of *Multiple impact therapy* described as a time-limited series

of clinical encounters between several therapists and a single patient oriented toward a specific therapeutic goal. Hoffman et al. (1987) asserted that 2 therapists treating 1 patient is an effective technique not only in dealing with therapeutic impasses but as a therapeutic technique by itself. The multiple psychological intervention is an important factor in ensuring the effectiveness of counseling of this app, which provides a much shorter and simpler form of counseling than face-to-face counseling.

3.2.1.3. CBT-based comment intervention. We designed this app to utilize CBT-based comments of maximum 200 characters as the consultation method. Typically, counselors must spend a great deal of time text chatting and video counseling, which makes it difficult to find many available counselors because the approach requires higher levels of counselor time and expertise. This app allows counselors to provide counseling to larger numbers of clients by reducing their counseling burden to the provision of short comments.

3.2.1.4. Gamification. The success of the app depends on the participation of a large number of counselors. We, therefore, designed the app to include features that enable clients to give rewards, named *sprouts*, to the counselor who provided the most helpful comment (Figure 3); counselors can thus collect these *sprouts* and keep track of their achievements. Counselors' occupational performance requires rewards such as gratification (Petrowski et al., 2014). Through the gamification factor, we intended that the counselor would continue to participate in the counseling with a sense of accomplishment along with rewarding when their comments were adopted.

By implementing the above four core features through 'mobile apps', we have secured additional basic features that are anonymity, low cost, and the ability to consult anytime and anywhere.

3.2.2. Processes

In this app, the collection of personal information was minimized in order to secure anonymity and protect privacy. The client's information was collected only by gender and birth year & month. In addition to the above information, we collected only the final degree and the number of years in counseling more for counselors. Therefore, both client and counselor are identified by unique id. In counseling, the counselor is provided only with the client's gender, age, posting time, and physical distance from the client.

The two major user usage processes of the app are posting and intervening. Figure 1 shows the overall user flow diagram.

3.2.2.1. Posting. We designed the process by which clients publish their posts with two significant points in mind. First, we designed the process clients use to post emotions to be easy and intuitive (Figure 2a); they can post their current emotional states easily using the one-dimensional positive-to-negative slide bar and review their posted emotions intuitively by the expression of emoji changed based on the slide bar location. In contrast to the frequently used two-dimensional model (Valence vs Arousal), the one-dimensional model has the merit of allowing the user to more easily leave emotional states, and also has the advantage that it can be easily compared with the changed emotion numerical value recorded after the counselor's comment based intervention in the future. In addition to the positive-negative emotion slide bar, the present emotion is easily expressed in more detail by expressing

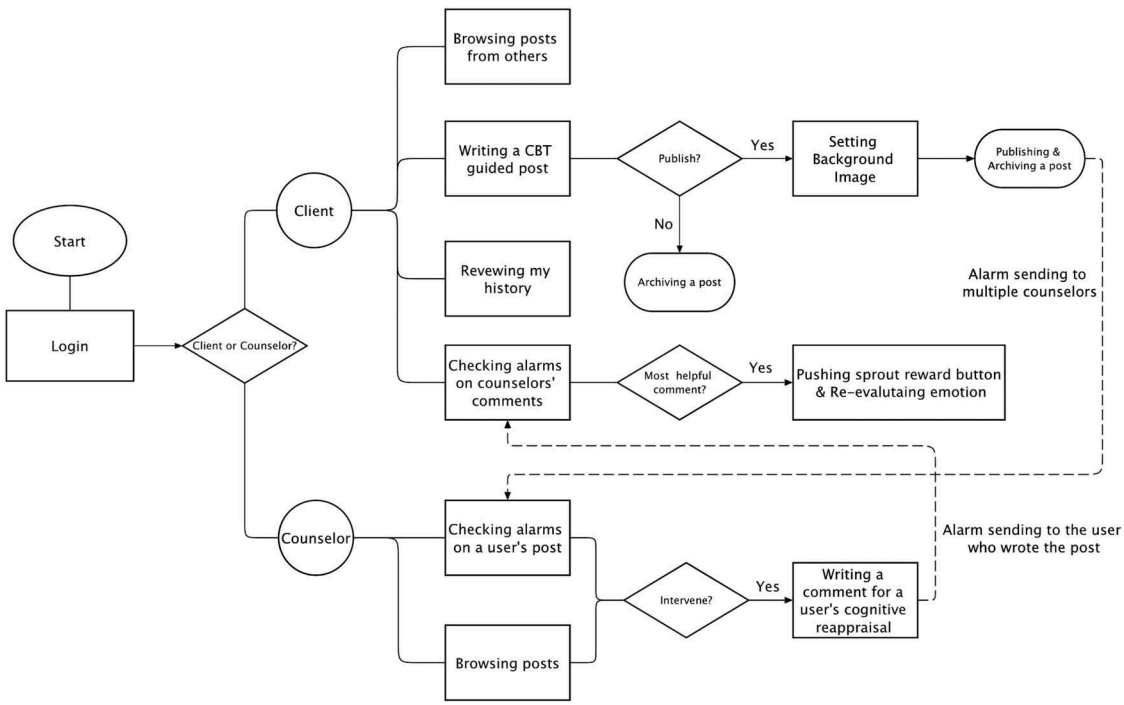

Figure 1. User experience flow diagram in *Spring*. Users write their emotions, situations, and thoughts, and then, self-assess themselves; after posting publicly, users receive counselor interventions and can then re-appraise the cognition of their feelings, situations, and thoughts.

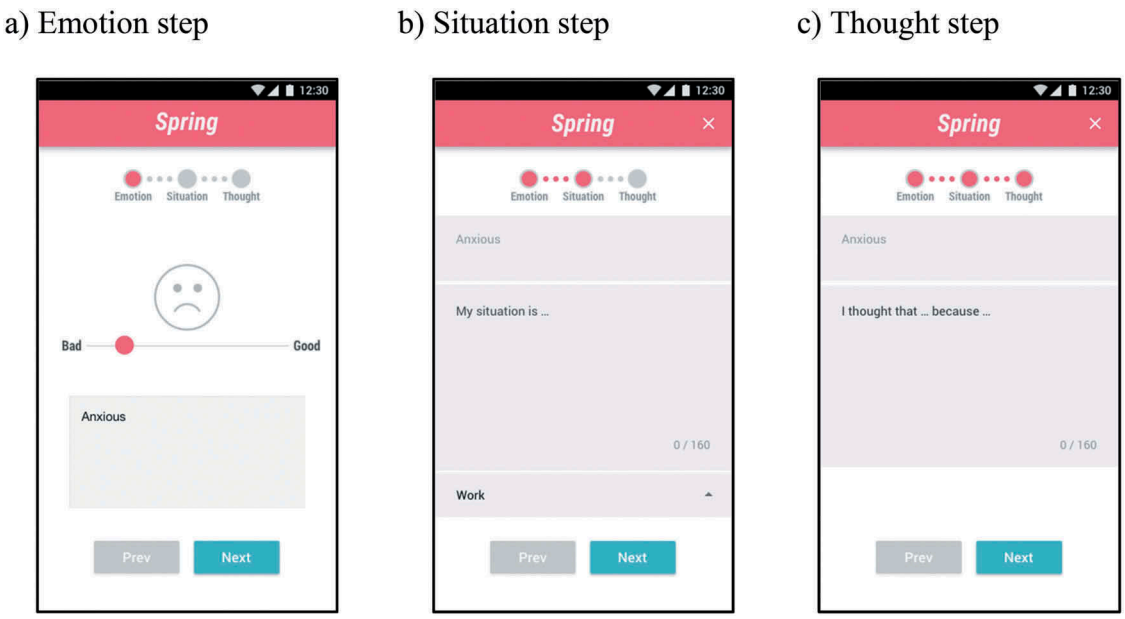

Figure 2. Posting process. a) Emotion step: a client can select his/her current emotion using the slide bar and describe it in more detail in the lower area with keywords (left); b) Situation step: a client can describe the situation in which the reported emotion occurred; also, a client can select one of several categories, such as study, work, family, and friend, to classify the situation (center); c) Thought step: a client can describe in detail his/her thoughts and the reason for these thoughts (right).

the current emotion state in one or more keywords. Second, we designed the client posting process based on CBT using three steps: emotion-situation-thought (Figure 2). In other words, the process enables clients to summarize their stories following a specific sequence: current emotion, the situation where the emotion occurred, and the thoughts they had at that time with maximum 160 characters per stage. This process can train clients to separate emotions, situations, and thoughts, enabling them to better control their own emotions; it can also help counselors consult more easily and effectively by providing them with organized counseling content.

Besides, the user can decide whether to publish his/her post or keep it private. Only the post that has been published can receive help from counselors. When the post is published, it is done anonymously to protect the client's privacy. However, users can keep the post private just to archive the daily emotions (good or bad) without asking for help. The app can visualize the archived emotional state changes when users want to review their emotions (Figure 4). In addition, the backdrop of one's writing can be selected from various images so that his/her emotional state could be expressed more intuitively (Figure 5). Finally, to broaden clients' perspectives and enable them to give one another psychological support, we have added community features that allows clients to easily browse posts open to the public with swipe interaction and to express their sympathy by pressing a red heart-shaped icon (Figure 5).

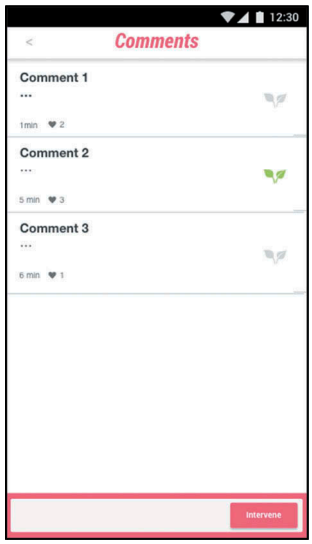

Figure 3. Giving rewards. A client can select one of the comments from various counselors and provide a *sprout* as a reward to the counselor by pressing the *sprout* icon.

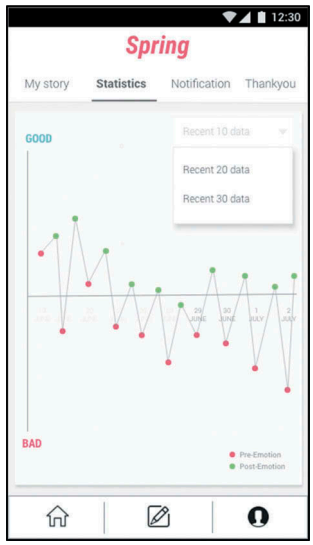

Figure 4. Visualizing the history of pre- and post-emotions. Clients can review the changes in their emotions after they receive comments from various counselors.

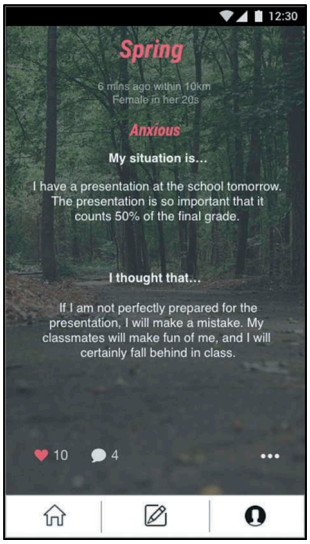

Figure 5. An example of a user post. A client's post that summarizes the client's emotion, situation, and thoughts after he/she successfully finished the process of writing, providing his/her age, gender, posting time, and distance information.

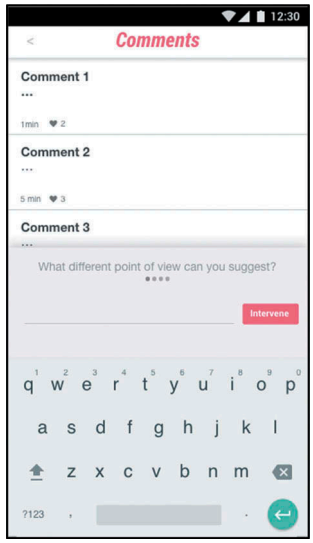

Figure 6. Comment-based interventions. Counselors provide cognitive reappraisal comments (maximum 200 characters) on a client's post, helped by socratic guidelines.

3.2.2.2. Intervening. To ensure the counseling expertise of the counselors using the app, we designed the app to only allow users who are qualified and registered as counselors in the app to leave counseling comments. In designing the process of counselor intervention, we considered the fact that mobile counseling occurs within limited mobile environments (e.g. on small screens) different from the environments of traditional face-to-face counseling. Therefore, it is important to make it easier for the counselors to understand the problems of individual clients. To accomplish this and assist counselors in providing counseling, we designed the app to present counselors with clients' emotion-situation-thought summaries on single cards that do not require scrolling and also include clients' basic information such as age, gender, posting time, and distance from counselors. In addition, we designed the app to provide the following guidelines – based on the Socratic approach, which is known as an effective CBT method (Clark & Egan, 2015) – when counselors write comments: "How can you see the situation from a different perspective?," "If your family or close friends were experiencing a similar situation, what would you like to tell them?," "Find some evidence that contradicts your thoughts." (Figure 6). Finally, we designed the app to enable counselors to monitor their counseling skills by providing an archiving function that allows them to review comments they provided.

3.3. Implementation

To implement the proposed method in the form of a mobile app, we used the Angular 2 framework for front-end development, Node.js for back-end development, and the ionic framework to develop a hybrid app that can be used on both iOS and Android devices.

4. Experiment

4.1. Participants

We recruited a total of 68 participants through online advertising and then randomly assigned them to the experimental group (App-using group, 34 participants) and the wait-list control group (34 participants). We excluded 6 participants in the experimental group and 3 participants in the wait-list control group who did not participate in the pre-questionnaire to measure depression and anxiety; so, a total of 59 participants (28 in the experimental group and 31 in wait-list control group) initially participated in the two-week experiment. In the final analysis, we used data from 25 participants in the experimental group and 22 participants in the wait-list control group, excluding 3 participants in the experimental group and 9 participants in the wait-list control group who did not complete the post-UX questionnaire after the two weeks. In addition, 10 graduate students (7 graduate students majoring in counseling psychology and 3 graduate students majoring in clinical psychology), who have taken CBT courses at a university, participated in the experiment as counselors.

4.2. Procedure

Before the experiment began, we measured the current depression and anxiety level of the participants in both the experimental and wait-list control groups. Participants in the experimental group used the app for two weeks and were instructed to leave at least one post per day in the app, while participants in the wait-list control group could not use the app when it was being used by the experimental group. Depression and anxiety levels were measured again in both the experimental group and the wait-list control group after 2 weeks. The participants in the experimental group were additionally asked about the user experience (UX) of the app.

To provide multiple comments on the posts left by the client participants, counselors were instructed to leave at least seven comments per day. We also investigated the UX of the counselors after they had used the app for two weeks.

4.3. Measures

4.3.1. Depression and anxiety

In this study, we used *Beck Depression Inventory-II* (*BDI-II*: Beck et al., 1996) to measure depression before and after using the app and participants responded to a total of 21 questions on a 4-point scale. To measure anxiety, we used *State Trait Anxiety Inventory-Trait Scale* (STAI-T: Spielberger et al., 1970). STAI-T examines Trait Anxiety, which people generally feel in their daily lives, using a total of 20 questions on a 4-point scale.

4.3.2. User experience

We evaluated the clients' user experience (UX) by six items – availability, accessibility, acceptability, usability, desirability, and usefulness. These evaluation items were based on user needs extracted from the previous studies (Chan et al., 2015; Doherty et al., 2010) and our user research with a small group of people who had counseling experience. A total of 11 questions corresponding to each of the features in Table 1 were rated by participants on 7-point scales. In addition, we surveyed the clients' positive and negative experiences in using the app with open-ended questions. Finally, participants rated their overall satisfaction using the visual analogue scale (VAS).

Counselors also provided UX evaluations by responding to eight questions corresponding to each of the eight features in Table 1 on 7-point scales. Additionally, they evaluated their overall satisfaction and the overall effectiveness of the app for counseling training via VAS and we surveyed their positive and negative experiences in using the app with open-ended questions.

5. Results

5.1. Demographics and psychological characteristics

Table 2 shows the demographic characteristics of age, gender, and the Operating Systems (OS) of devices participants used in both the experimental and wait-list control groups. We found no significant differences between the two groups regarding these three items.

Table 3 shows the BDI-II and STAI-T pre-scores for the experimental and wait-list control groups. The pre-assessment BDI-II scores for the experimental and wait-list control groups (M = 11.96, SD = 7.20 vs M = *10.23, SD = 7.29*) showed no significant between-group differences ($t(45)$ =.82, p = .42). Likewise, the pre-assessment STAI-T scores for the experimental and wait-list control groups (M = *46.60, SD = 7.83* vs M = *45.73, SD = 9.96*) showed no statistically significant between-group differences ($t(45)$ = .34, p = .74).

Table 2. Demographic and psychological characteristics of client participants.

	App-using group (N = 25)	Wait list control group (N = 22)	p
Age	21.00	21.95	.127
Sex			.731
Male	8 (32%)	6 (27%)	
Female	17 (68%)	16 (73%)	
Device			.713
iOS	15 (60%)	12 (55%)	
Android	10 (40%)	10 (45%)	

5.2. Depression & anxiety changes in app-using group vs control group

The BDI-II scores for the experimental group showed a statistically significant decrease in depression (t (24) = 2.85, p = .01) between the pre-assessment (M = 11.96, SD = 7.20) and post-assessment (M = 9.20, SD = 6.49) after 2 weeks. The BDI-II scores for the wait-list control group were slightly elevated, though the difference was not statistically significant. In the STAI-T score, there was no statistically significant difference between before and after the experiment in both the experimental and control groups. The results of the experiment thus suggest that the proposed app can help alleviate clients' depression.

5.3. App usage statistics

The participants in the experimental group wrote a total of 247 posts over the two weeks of using the app, amounting to an average of about 10 posts per user. When writing a post, the clients recorded their emotions by moving the slider (0: the most negative, 100: the most positive). 90 of the 247 posts (36%) were left with negative emotional values with negative keywords (tired, nervous, annoying, etc.). On the other hand, 140 of the 247 posts (57%) were left with positive emotional values with positive keywords (satisfied, relaxed, comfortable, etc.). For the remaining 17 (7%) posts, the slider value was left at default (50). Regarding the posting time, 175 (71%) of the total posts were written between 10:00 AM and 5:00 PM. Also, in 126 of the total posts (51%), the clients adopted one of the most helpful comments and then reported once again his current emotions. The clients reported that their emotion positiveness rose by an average of 20.35 after receiving comments from counselors.

5.4. User experience survey results

5.4.1. Quantitative analysis

In the UX evaluation conducted on the participants in the experimental group, clients rated the acceptability, accessibility, and availability of the UX factors over 6 on average out of

Table 3. Pre- and post-depression and anxiety level in app-using group vs. wait-list control group.

	App-using group (N = 25)				Wait-list control group (N = 22)			
	Pre	Post	t	p	Pre	Post	t	p
BDI-II	*11.96 ± 7.20*	*9.20 ± 6.49*	*2.85*	*.01*	*10.23 ± 7.29*	*12.41 ± 8.85*	*−1.76*	*.09*
STAI-T	*46.60 ± 7.83*	*46.04 ± 7.72*	*.41*	*.68*	*45.73 ± 9.96*	*48.73 ± 10.23*	*−1.99*	*.06*

Note. BDI-II: Beck Depression Inventory-II; STAI-T: State-Trait Anxiety Inventory-Trait

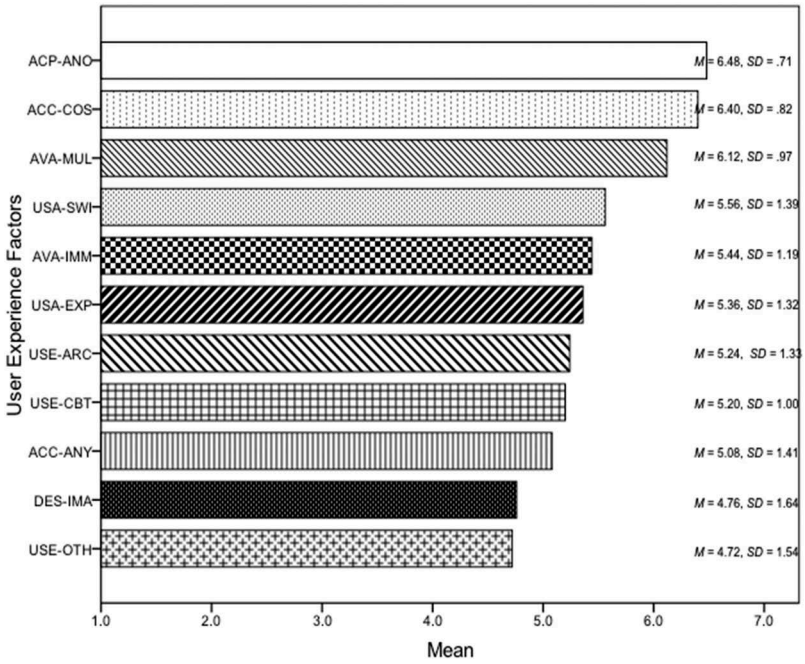

Figure 7. UX evaluation of Spring App features from client participants. see Table 2 for the meanings of the symbols.

7-point Likert scale (See Figure 7). Clients identified counseling via anonymous writing (ACP-ANO, *M* = 6.48, *SD* = *.71*), cost-free counseling (ACC-COS, *M* = 6.40, *SD* = *.82*), counseling through comments from multiple counselors (AVA-MUL, *M* = 6.12, *SD* = .97) as the app's most helpful features, rating them over 6 out of 7. In addition, clients reported that browsing via swipe interaction (USA-SWI, *M* = 5.56, *SD* = *1.39*), prompt comment-based intervention within 24 hours (AVA-IMM, *M* = 5.44, *SD* = *1.19*), the simple process of reporting emotion via one slide bar (USA-EXP, *M* = 5.36, *SD* = *1.32*), archiving and visualizing past emotions and posts (USE-ARC, *M* = 5.24, *SD* = *1.33*), posting via 3 stages (emotion-situation-thought) based on CBT principles (USE-CBT, *M* = 5.20, *SD* = *1.00*), and counseling anytime and anywhere (ACC-ANY, *M* = 5.08, *SD* = *1.41*) were helpful features when using the app, rating them over 5. However, they reported that features such as allowing users to choose among various background images (DES-IMA, *M* = 4.76, *SD* = *.71*) and reviewing counseling posts from others (USE-OTH, *M* = 4.72, *SD* = *.71*) were relatively less helpful when using the app. In the overall satisfaction survey, clients generally reported that they were satisfied with the app, rating it 73 out of 100 (*SD* = *17.52*).

We conducted Pearson correlation analysis to examine the correlation between overall satisfaction and the above 11 UX design items (Figure 8). The results showed significant positive correlations between overall satisfaction and both anonymity (r = .60, p < .01) and comments from multiple counselors (r = .49, p < .05). This implies that both acceptability and availability were positively correlated with the overall satisfaction of *Spring* users.

On the other hand, counselors identified the *sprout*, the reward for comments clients found most useful, as the most helpful UX design feature for counseling (REW-SPR, *M* = 5.90, *SD* = .73). They also noted that the following features were helpful for counseling: counseling via simplified comments without face-to-face communication (USA-COM, *M* = 4.90, *SD* = 1.45), browsing counselors' past counseling history (USE-ARC, *M* = 4.70, *SD* = *1.16*), receiving clients' age and gender information (USA-AGE, *M* = 4.50, *SD* = *2.01*), and receiving clients' posts organized in 3 CBT-based stages: emotion, situation, and thoughts (USE-CBT, *M* = 4.50, *SD* = *1.27*). However, they found that the following features were not particularly helpful for counseling (Figure 9): receiving clients' posting time information (USA-TIM, *M* = 4.10, *SD* = *1.37*), counseling anytime and anywhere that they wanted (ACC-ANY, *M* = 4.00, *SD* = *1.70*), and receiving information about the geographical distance from clients (USA-DIS, *M* = 2.30, *SD* = *1.52*). On the other hand, when asked whether the app helped with counseling training, they gave it an average rating of 72.1 (*SD* = *18.94*) out of 100, meaning the app was moderately helpful in counseling training. In the overall satisfaction survey, counselors gave the app an average rating of 66.1 (*SD* = 18.96) out of 100, indicating that they were moderately satisfied with the app, but less satisfied than clients (M = 73).

5.4.2. Qualitative analysis

In open-ended questions to the clients in the experimental group, we asked, "What did you like the most about using the app?" Most clients reported that reviewing or looking back at their feelings with an objective perspective while writing was the most helpful for them.

> *"I was a happier person than I thought, and I realized that the change of emotions is greater than I thought." (20 years old, Male)*

> *"I was able to look at my situation a bit more objectively writing my post." (22 years old, Male)*

"Being able to record the emotions of the day itself was helpful" (19 years old, Female)

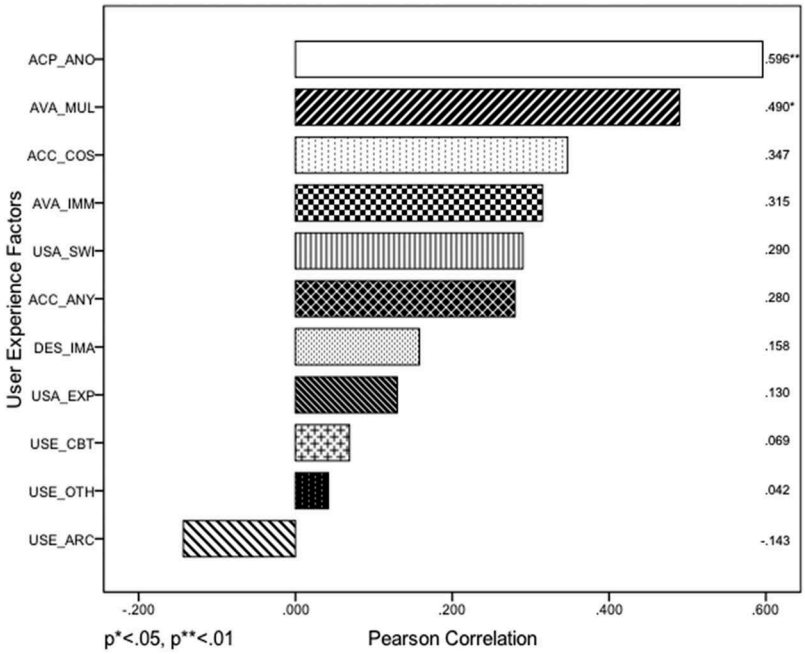

Figure 8. Correlation between each Spring feature and user satisfaction in the experimental group. see Table 2 for the meanings of the symbols.

Additionally, many clients reported that the high quality of the comments and the multiple feedbacks from various counselors were helpful in counseling.

> *"I was able to receive replies from several counselors, and I was able to see my situation in various ways." (19 years old, Female)*

"The comments from the counselors were all very precious words." (19 years old, Female)

We also asked the clients: "What did you think would be the best way to improve the app?" The most mentioned ones were more choices for background images and more community features.

"I wish there was a wider range of background images." (22 years old, Female)

> *"There are some writings that I sympathize with as I sometimes want to comment, but I could not comment." (20 years old, Male)*

"I want to give more than one sprout." (19 years old, Female)

We also asked, "What did you like the most about using the app?", to the counselors who participated in the experiment. Most counselors mentioned the usefulness of the app's feature – multiple intervention – in self counseling skill training.

"I realized what kind of response is a good response that the client sympathizes with." (Counselor 9, Female)

> *"I was able to think from a different point of view through the comments of other counselors." (Counselor 3, Female)*

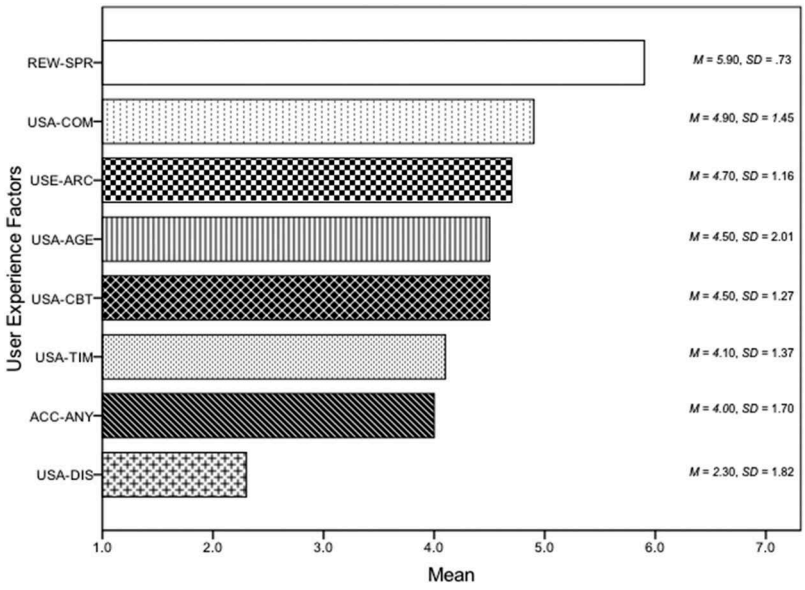

Figure 9. UX evaluation of Spring App features from counselor participants. see Table 2 for the meanings of the symbols.

"Viewing the comments from other counselors could be a study for counseling training." (Counselor 1, Female)

In addition, many counselors reported that they felt a sense of reward and fulfillment when the client expressed their gratitude via *sprouts*.

"I felt the joy of being helpful to someone although it was done online." (Counselor 2, Female)

> *"When the client sent a sprout or thank-you note to me, I felt my efficacy increased." (Counselor 6, Female)*

"I felt a sense of accomplishment as I posted comments." (Counselor 10, Female)

Meanwhile, we also asked counselors: " What did you think would be the best way to improve the app?" Many counselors reported that they felt burdened by the time-consuming and time-sensitive nature of the counseling.

> *"Although it was a short comment, it took a lot of time to understand the client's position and to write without misunderstanding." (Counselor 3, Female)*

> *"Due to late requests for feedback from clients, I felt fatigued and burdened." (Counselor 8, Female)*

"Providing real-time comments became a burden." (Counselor 7, Female)

In addition, some counselors felt inconvenienced and stated that the app needed improvement in terms of usability, highlighting problems with the character limits for comments and the trouble in having to check clients' posts while writing comments due to small screen size.

"I could not see the client's post while commenting." (Counselor 3, Female)

"I think the 200-character limit is too low for writing comments." (Counselor 8, Female)

6. Discussion

Our experimental results on depression aligns with previous studies that psychological interventions using CBT on mobile apps could alleviate depression in app users (Arean et al., 2016; Watts et al., 2013). In general, CBT-based mobile apps are based on a variety of CBT-based guides. We need to note that that this app reduced clients' depression with very simple one or two-sentence comments provided by multiple counselors. In particular, in their post-experiment feedback, the users used the keywords "healing," "comfort," or "sympathy" to describe the positive experience of having someone take interest in and respond to their posts. This implies that, although counselors' interventions may be superficial and shorter than in face-to-face counseling, immediate interventions from several counselors can be effective providing the client with a sense of being cared.

"Counselors gave their comments carefully." (20 years old, Male)

"There is someone who comforts me." (22 years old, Female)

"Immediate feedback was helpful" (21 years old, Female)

However, our experiment did not confirm that the app mitigated anxiety, unlike previous studies showing that mobile-based CBT can be effective in treating anxiety as well as depression (Mohr et al., 2017; Proudfoot et al., 2013). This is presumably because the 2-week period was not enough to produce changes in the trait-anxiety index used to measure anxiety in this experiment. Further longer-period study about the efficacy of the app on anxiety is needed.

Analysis of the responses to the questions used to evaluate UX showed statistically significant correlations between overall satisfaction and both anonymity and comments from multiple-counselors. This finding suggests that clients might have been most dissatisfied with these factors in traditional face-to-face counseling. In other words, lack of anonymity and fewer opportunities to receive counseling from satisfactory counselors might have been the most dissatisfactory dimensions in traditional counseling settings.

Interestingly, however, the clients gave the lowest rating to the statement "It was helpful to see the anonymous counseling of others updated in real time," among the 11 UX questions. This is somewhat contradictory to the general expectation that knowing that others have similar problems is helpful as said by one of the counselor participants.

> *"From the perspective of users, I think it would be useful to know that I was not the only one to worry by seeing that other people had similar problems." (Counselor 3, Female)*

This might be because 1) clients may not read many other posts because they have less energy to care for others when they have psychological problems or 2) clients may not have a chance to get help from others' posts because the app does not have a feature that enables them to find posts about problems similar to theirs.

We need to note the part of the counselor's report that this app has helped counseling skills training. Becoming a certified counselor requires a long training period. It is also difficult to experience many different cases through one-to-one face-to-face counseling during the period. In this app, multiple counselors can intervene on one client and see what comments are being adopted by the client, which is hard to achieve with the traditional training settings.

"I could see what comments the clients found useful based on their selections." (Counselor 10, Female)

"I liked that I could see how other counselors commented." (Counselor 2, Female)

These points imply that this app can serve as a useful tool in counseling training, giving counselors opportunities to practice their counseling skills by allowing them to experience various cases and observe the different counseling approaches used by other counselors. However, presumably the fact that the short comments proved more difficult, time-consuming, and inconvenient than expected caused the counselors to rate their overall satisfaction with the app a little lower than they rated its usefulness.

This preliminary study has several limitations. First, the participants in the experiment were limited to non-clinical college students in their 20 s. Therefore, generalizing the results to clinical groups or other age groups is difficult. Secondly, the fact that the participants only used the app for two weeks – a relatively short period – is another limitation. As a result, we were unable to confirm the long-term efficacy of the app. Thirdly, in South Korea, it is not necessary to have a certificate to provide psychological counseling, but this

model may not be possible in other countries because some countries may require a certificate for psychological counseling. Finally, we were not able to confirm the impact of local homogeneity on counseling, since most of the counselors and the clients in the experiment lived in the same city.

7. Conclusion

In this paper, we proposed a mobile app, *Spring*, to help reduce common mental health symptoms such as mild depression that many people experience in everyday life. The proposed app features semi-crowdsourced counseling, immediate intervention from multiple counselors, CBT-based short writing, and gamification to solve the problems of availability, acceptability, and accessibility in traditional face-to-face counseling. To investigate the efficacy of the app and how each UX design element affects the experiences of clients and counselors, we conducted a 2-week RCT on 47 college students in their 20 s. From the preliminary experimental study, we found that the depression of only the participants who used the proposed app prototype decreased significantly. Regarding UX, the majority of the participants who used the proposed app as clients reported that both being able to objectively view their emotions and receive immediate psychological support from multiple counselors were helpful. In addition, the majority of the counselors using the app reported that the app was helpful in counseling skill training. In particular, the insight counselors acquired from seeing which comments clients selected would be difficult to acquire from traditional counseling; therefore, this app could be used as a useful training aid tool in the future.

Future research is needed particularly in three areas. First, we need to further research how to reward counselors so that many people can be motivated to participate in the app as counselors. Implementing advertising targeted to mental health industries and allowing the counselors to monetize *sprouts* they collect could be one of the ways to explore. Also allowing the counselors to use the collected *sprouts* and counseling time on the app toward fulfilling the counseling training time requirements to be a certified counselor would make it more widely adopted as a new training tool. Second, we need to research how to enable more people to quickly become qualified counselors of the app when they want to join the app as counselors after motivated by a monetary reward or other reasons. Without requiring them to take formal CBT training, which is typically part of the long curriculum in psychology, the app should provide a way they can become well equipped with required CBT knowledge and skills. Many mobile apps provide a CBT skill training program, but we need to research how to create a mobile based program that can be proved at least as effective as traditional training in terms of both knowledge and skills and that can be finished in much shorter period of time with low dropout rate. Utilizing gamification could be one way to explore. Lastly, more UX research on the comment-writing process is necessary based on the counselors' feedback regarding the difficulty and time-consuming nature of commenting on the smartphone. The process is one of the most important parts in this app-based counseling, and it should be easier and less-time consuming in order to make counselors continue to use the app.

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References

Arean, P. A., Hallgren, K. A., Jordan, J. T., Gazzaley, A., Atkins, D. C., Heagerty, P. J., & Anguera, J. A. (2016). The use and effectiveness of mobile apps for depression: Results from a fully remote clinical trial. *Journal of Medical Internet Research*, *18*(12), e330. https://doi.org/10.2196/jmir.6482

Bakker, D., Kazantzis, N., Rickwood, D., & Rickard, N. (2016). Mental health smartphone apps: Review and evidence-based recommendations for future developments. *JMIR Mental Health*, *3*(1), e7. https://doi.org/10.2196/mental.4984

Bardram, J. E., Frost, M., Szántó, K., Faurholt-Jepsen, M., Vinberg, M., & Kessing, L. V. (2013, April). *Designing mobile health technology for bipolar disorder: A field trial of the monarca system*. Proceedings of the SIGCHI conference on human factors in computing systems, Paris, France, 2627–2636. ACM. https://doi.org/10.1145/2470654.2481364

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Beck depression inventory-II*. Psychological Corp. *78*(2).

Birney, A. J., Gunn, R., Russell, J. K., & Ary, D. V. (2016). MoodHacker mobile web app with email for adults to self-manage mild-to-moderate depression: Randomized controlled trial. *JMIR mHealth and uHealth*, *4*(1), e8. https://doi.org/10.2196/mhealth.4231

Butler, A. C., Chapman, J. E., Forman, E. M., & Beck, A. T. (2006). The empirical status of cognitive-behavioral therapy: A review of meta-analyses. *Clinical Psychology Review*, *26*(1), 17–31. https://doi.org/10.1016/j.cpr.2005.07.003

Chan, S., Torous, J., Hinton, L., & Yellowlees, P. (2015). Towards a framework for evaluating mobile mental health apps. *Telemedicine and e-Health*, *21*(12), 1038–1041. https://doi.org/10.1089/tmj.2015.0002

Chen, J., & Hou, F. (2002). Unmet needs for health care. *Health Rep*, *13*(2), 23–34. https://www.ncbi.nlm.nih.gov/pubmed/12743954

Chiu, T. M., & Eysenbach, G. (2010). Stages of use: Consideration, initiation, utilization, and outcomes of an internet-mediated intervention. *BMC medical informatics and decision making*, *10*(1), 73. https://doi.org/10.1186/1472–6947–10–73

Churchill, R., Hunot, V., Corney, R., Knapp, M., McGuire, H., Tylee, A., & Wessely, S. (2002). A systematic review of controlled trials of the effectiveness and cost-effectiveness of brief psychological treatments for depression. *Health Technology Assessment*, *5*(35), 1–173. https://doi.org/10.3310/hta5350

Clark, G. I., & Egan, S. J. (2015). The socratic method in cognitive behavioural therapy: A narrative review. *Cognitive Therapy and Research*, *39*(6), 863–879. https://doi.org/10.1007/s10608-015-9707-3

Davies, S. C. (2014). *Annual report of the chief medical officer 2013, public mental health priorities: Investing in the evidence*. Department of Health.

Demyttenaere, K., Bruffaerts, R., Posada-Villa, J., Gasquet, I., Kovess, V., Lepine, J., … Kikkawa, T. (2004). Prevalence, severity, and unmet need for treatment of mental disorders in the World Health Organization World Mental Health Surveys. *Jama*, *291*(21), 2581–2590. https://doi.org/10.1001/jama.291.21.2581

Doherty, G., Coyle, D., & Matthews, M. (2010). Design and evaluation guidelines for mental health technologies. *Interacting with Computers*, *22*(4), 243–252. https://doi.org/10.1016/j.intcom.2010.02.006

Firth, J., & Torous, J. (2015). Smartphone apps for schizophrenia: A systematic review. *JMIR mHealth and uHealth*, *3*(4), e102. https://doi.org/10.2196/mhealth.4930

Firth, J., Torous, J., Nicholas, J., Carney, R., Pratap, A., Rosenbaum, S., & Sarris, J. (2017a). The efficacy of smartphone-based mental health interventions for depressive symptoms: A meta-analysis of randomized controlled trials. *World Psychiatry*, *16*(3), 287–298. https://doi.org/10.1002/wps.20472

Firth, J., Torous, J., Nicholas, J., Carney, R., Rosenbaum, S., & Sarris, J. (2017b). Can smartphone mental health interventions reduce symptoms of anxiety? A meta-analysis of randomized controlled trials. *Journal of Affective Disorders*, *218*, 15–22. https://doi.org/10.1016/j.jad.2017.04.046

Fitzpatrick, K. K., Darcy, A., & Vierhile, M. (2017). Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (Woebot): A randomized controlled trial. *JMIR Mental Health*, *4*(2), e19. https://doi.org/10.2196/mental.7785

Gravenhorst, F., Muaremi, A., Bardram, J., Grünerbl, A., Mayora, O., Wurzer, G., … Tröster, G. (2015). Mobile phones as medical devices in mental disorder treatment: An overview. *Personal and Ubiquitous Computing*, *19*(2), 335–353. https://doi.org/10.1007/s00779-014-0829-5

Green, H., McGinnity, A., Meltzer, H., Ford, T., & Goodman, R. (2005). *Mental health of children and young people in Great Britain, 2004*. Office for National Statistics.

Grist, R., Porter, J., & Stallard, P. (2017). Mental health mobile apps for preadolescents and adolescents: A systematic review. *Journal of Medical Internet Research*, *19*(5), e176. https://doi.org/10.2196/jmir.7332

Hoffman, S., Kohener, R., & Shapira, M. (1987). Two on one: Dialectical psychotherapy. *Psychotherapy: Theory, Research, Practice, Training*, *24*(2), 212. https://doi.org/10.1037/h0085706

Hofmann, S. G., Asnaani, A., Vonk, I. J., Sawyer, A. T., & Fang, A. (2012). The efficacy of cognitive behavioral therapy: A review of meta-analyses. *Cognitive Therapy and Research*, *36*(5), 427–440. https://doi.org/10.1007/s10608-013-9595-3

Hofmann, S. G., & Smits, J. A. (2008). Cognitive-behavioral therapy for adult anxiety disorders: A meta-analysis of randomized placebo-controlled trials. *The Journal of Clinical Psychiatry*, *69*(4), 621–632. https://doi.org/10.4088/jcp.v69n0415

Hollis, C., Falconer, C. J., Martin, J. L., Whittington, C., Stockton, S., Glazebrook, C., & Davies, E. B. (2017). Annual research review: Digital health interventions for children and young people with mental health problems–a systematic and meta-review. *Journal of Child Psychology and Psychiatry*, *58*(4), 474–503. https://doi.org/10.1111/jcpp.12663

Huguet, A., Rao, S., McGrath, P. J., Wozney, L., Wheaton, M., Conrod, J., & Rozario, S. (2016). A systematic review of cognitive behavioral therapy and behavioral activation apps for depression. *PLoS One*, *11*(5), e0154248. https://doi.org/10.1371/journal.pone.0154248

Kessler, R. C., Berglund, P. A., Bruce, M. L., Koch, J. R., Laska, E. M., Leaf, P. J., … Wang, P. S. (2001). The prevalence and correlates of untreated serious mental illness. *Health Services Research*, *36*(6 Pt 1), 987–1007. Retrieved from http://www.hsr.org/

Kuhn, E., Greene, C., Hoffman, J., Nguyen, T., Wald, L., Schmidt, J., … Ruzek, J. (2014). Preliminary evaluation of PTSD coach, a smartphone app for post-traumatic stress symptoms. *Military Medicine*, *179*(1), 12–18. https://doi.org/10.7205/MILMED-D-13-00271

Lovell, K., & Richards, D. (2000). Multiple access points and levels of entry (MAPLE): Ensuring choice, accessibility and equity for CBT services. *Behavioural and Cognitive Psychotherapy*, *28*(4), 379–391. https://doi.org/10.1017/S1352465800004070

Luxton, D. D., McCann, R. A., Bush, N. E., Mishkind, M. C., & Reger, G. M. (2011). mHealth for mental health: Integrating smartphone technology in behavioral healthcare. *Professional Psychology: Research and Practice*, *42*(6), 505. https://doi.org/10.1037/a0024485

Martínez-Pérez, B., De La Torre-Díez, I., & López-Coronado, M. (2013). Mobile health applications for the most prevalent conditions by the World Health Organization: Review and analysis. *Journal of Medical Internet Research*, *15*(6), e120. https://doi.org/10.2196/jmir.2600

Merikangas, K. R., He, J. P., Burstein, M., Swanson, S. A., Avenevoli, S., Cui, L., & Swendsen, J. (2010). Lifetime prevalence of mental disorders in US adolescents: Results from the National Comorbidity Survey Replication–Adolescent Supplement (NCS-A). *Journal of the American Academy of Child & Adolescent Psychiatry*, *49*(10), 980–989. https://doi.org/10.1016/j.jaac.2010.05.017

Mohr, D. C., Tomasino, K. N., Lattie, E. G., Palac, H. L., Kwasny, M. J., Weingardt, K., Kaiser, S. M., Rossom, R. C., Bardsley, L. R., Caccamo, L., Stiles-Shields, C., Schueller, S. M., & Karr, C. J. (2017). IntelliCare: An eclectic, skills-based app suite for the treatment of depression and anxiety. *Journal of Medical Internet Research*, *19*(1), e10. https://doi.org/10.2196/jmir.6645

Morris, R. R., Schueller, S. M., & Picard, R. W. (2015). Efficacy of a Web-based, crowdsourced peer-to-peer cognitive reappraisal platform for depression: Randomized controlled trial. *Journal of Medical Internet Research*, *17*(3), e72. https://doi.org/10.2196/jmir.4167

Olff, M. (2015). Mobile mental health: A challenging research agenda. *European Journal of Psychotraumatology*, *6*(1), 27882. https://doi.org/10.3402/ejpt.v6.27882

World Health Organization. (2017). *Depression and other common mental disorders: Global health estimates* (No. WHO/MSD/MER/2017.2).

Petrowski, K., Hessel, A., Eichenberg, C., & Brähler, E. (2014). Occupational stressors in practicing psychological psychotherapists. *Health*, *6*(5), 378. https://doi.org/10.4236/health.2014.65055

Piaget, G. W., & Serber, M. (1970). Multiple impact therapy. *The Psychiatric Quarterly*, *44*(1–4), 114–124. https://doi.org/10.1007/BF01562962

Price, M., Yuen, E. K., Goetter, E. M., Herbert, J. D., Forman, E. M., Acierno, R., & Ruggiero, K. J. (2014). mHealth: A mechanism to deliver more accessible, more effective mental health care. *Clinical Psychology & Psychotherapy*, *21*(5), 427–436. https://doi.org/10.1002/cpp.1855

Proudfoot, J., Clarke, J., Birch, M. R., Whitton, A. E., Parker, G., Manicavasagar, V., & Hadzi-Pavlovic, D. (2013). Impact of a mobile phone and web program on symptom and functional outcomes for people with mild-to-moderate depression, anxiety and stress: A randomised controlled trial. *BMC Psychiatry*, *13*(1), 312. https://doi.org/10.1186/1471-244X-13-312

Rathbone, A. L., Clarry, L., & Prescott, J. (2017). Assessing the efficacy of mobile health apps using the basic principles of cognitive behavioral therapy: Systematic review. *Journal of Medical Internet Research*, *19*(11), e399. https://doi.org/10.2196/jmir.8598

Rice, D. P., & Miller, L. S. (1998). Health economics and cost implications of anxiety and other mental disorders in the United States. *The British Journal of Psychiatry*, *173*(S34), 4–9. https://doi.org/10.1192/S0007125000293458

Simon, G. E., & Ludman, E. J. (2009). It's time for disruptive innovation in psychotherapy. *The Lancet*, *374*(9690), 594–595. https://doi.org/10.1016/S0140-6736(09)61415-X

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *STAI manual for the state-trait inventory*. Consulting Psychologists Press.

Stawarz, K., Preist, C., Tallon, D., Wiles, N., & Coyle, D. (2018). User experience of cognitive behavioral therapy apps for depression: An analysis of app functionality and user reviews. *Journal of Medical Internet Research*, *20*(6), e10120. https://doi.org/10.2196/10120

Steinman, K. J., Shoben, A. B., Dembe, A. E., & Kelleher, K. J. (2015). How long do adolescents wait for psychiatry appointments? *Community Mental Health Journal*, *51*(7), 782–789. https://doi.org/10.1007/s10597-015-9897-x

Sucala, M., Cuijpers, P., Muench, F., Cardoș, R., Soflau, R., Dobrean, A., … David, D. (2017). Anxiety: There is an app for that. A systematic review of anxiety apps. *Depression and Anxiety*, *34*(6), 518–525. https://doi.org/10.1002/da.22654

Watts, S., Mackenzie, A., Thomas, C., Griskaitis, A., Mewton, L., Williams, A., & Andrews, G. (2013). CBT for depression: A pilot RCT comparing mobile phone vs. computer. *BMC Psychiatry*, *13*(1), 49. https://doi.org/10.1186/1471-244X-13-49

Woodward, L. J., & Fergusson, D. M. (2001). Life course outcomes of young people with anxiety disorders in adolescence. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*(9), 1086–1093. https://doi.org/10.1097/00004583-200109000-00018

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