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Article

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Abstract: Depressive symptoms often occurred during the adolescence period. This situation affected their psychological well-being. Thus, there is an urgent need to prevent mental health problems and promote psychological health outcomes among adolescents. Mobile health has been created as a platform to promote mental health to adolescents to ensure ongoing safety and effectiveness. Despite the positive evidence to support the mobile health, tailored mobile health to promote mental health and prevent psychological symptoms among adolescents in Thailand is lacking. This study aimed to assess the feasibility and acceptability of delivering digital technology intervention prototype called "MU-My-Mind Mobile Application (MU-My-mind App)" among Thai adolescents and evaluate the efficacy of this application in improving psychological health outcome. **Materials and Methods:** This quasi-experimental research was conducted in secondary school students in Thailand. A convenience sample was recruited and participants were asked to download the MU-My-Mind App on their smart phone. Health outcomes were also evaluated by self-administered questions and focus group interview at baseline and post-intervention. Feasibility and acceptability were assessed. Quantitative data were analyzed by descriptive statistics and pair t-test. Qualitative data were analyzed by thematic analysis. **Results:** Thirty students completed the MU-My-Mind application. Quantitative data suggested significant improvements on mindfulness, psychological well-being, depression, anxiety and stress. Qualitative data derived into six themes: a) overall feedback of the program, b) learning to manage stress and challenges, c) elevating relaxation responses and calmness, d) heightened mindfulness and concentration, e) increased awareness and management of emotions, and f) altering perspectives and managing thoughts. Overall, data suggested the acceptability and feasibility of the intervention. **Conclusion:** The "MU My Mind Mobile Application" prototype was demonstrated feasible and well acceptable among Thai secondary school student to promote their psychological health outcome. However, there are some limitation and suggestion emerged during this pilot testing. Future research should be explored in a larger sample size with comparison control group and over a longer duration with a range of diverse samples to ensure the efficacy of this application.

Keywords: mobile application; psychological well-being; depressive symptoms; adolescents

1. Introduction

In recent years, people who experienced depressive symptoms have increased worldwide. World Health Organization (WHO, 2021) reported that roughly 322 million people had depressive symptoms globally, which is approximately 4.4 % of the world populations. Looking at the high prevalence of depressive symptoms, adolescents are considered vulnerable populations. Evidence revealed that depressive symptoms often occurred during the adolescence period, which had three

to four times higher than childhood period (Shorey, S., Ng, E. D., & Wong, C. H., 2022). Previous studies found the onset of depressive symptoms among persons is at the age 15 to 19 years (Keyes, Gary, O'Malley, Hamilton & Schulenberg, 2019). However, recently literature revealed that depressive symptoms increase markedly around age 13 and almost 75% of adults with depression reported that their mental health problems began during adolescence (Lewis et al., 2017). (Besides, it was also reported that from 20 % to 50 % of adolescents had depressive symptoms and up to 20 % of them met criteria for depressive disorder by the age of 18 (Keyes, Gary, O'Malley, Hamilton & Schulenberg, 2019). These data showed that the onset of having depressive symptoms mostly happened in middle adolescence which make them considered as a vulnerable population. This situation affected their psychological well-being, which is an important element for a positive youth development. Thus, there is an urgent need to prevent such mental health problems and promote psychological health outcomes among adolescents.

Psychological well-being (PWB) is an indicator of positive psychology which included autonomy, self-acceptance, purpose in life, personal growth, positive relations with others, and environmental mastery (Ryff CD., 1989). Evidence have revealed PWB and depressive symptoms as negatively correlated (Zadow C, Houghton S, Hunter SC et al., 2017). Our previous study revealed the predictive power of mindfulness on psychological well-being in adolescents, as well as, identified the mediating role of mindfulness between stress and psychological well-being in Thai adolescent's population (Klainin-Yobas P, Ramirez D, Fernandez Z et al., 2016; Vongsirimas N, Sitthimongkol Y, Kaesornsamut P, et al., 2020).

Mobile health has been created as a platform to promote mental health to adolescents to ensure ongoing safety and effectiveness (Rickard, Arjmand, Bakker & Seabrook, 2016). Despite the positive evidence to support the mobile health (Fedele, D. A., Cushing, C. C., Fritz, A., Amaro, C. M., & Ortega, A., 2017; Konrath, S., 2015), tailored mobile health to promote mental health and prevent psychological symptoms among adolescents in Thailand is lacking. To fulfill such gap, the MU-My-Mind prototype was developed by the researchers for Thai adolescents. With this application, teachers and secondary school administrators will be able to promote mental health and prevent mental health problems in schools. This innovation aimed to transform its current mental health promotion delivery model, support self-direct monitoring, and finally improve psychological health outcomes in Thai adolescents. The present study reports results of a pilot study conducted to test feasibility and acceptability and evaluate the efficacy of the "MU-My-Mind Mobile Application (MU-My-Mind Apps)" on psychological well-being, mindfulness, stress, anxiety, and depressive symptoms within Thai adolescents' contexts.

2. Materials and Methods

This is single group, pre-posttest quasi-experimental research design conducted at one secondary school in Bangkok, Thailand between November to December 2019. The researchers have provided counseling services for students and teachers at this school for a few years. The researchers then realized that many students in this school experienced stress relating to academic work and other matters. Therefore, the researchers felt the need to develop a mobile application to help students deal with their stress. A convenience sampling was recruited. Eligible participants were students who; a) aged 13-18 years and b) had a smart phone or tablet with Android operating system version 6 or upper with internet access. Participants will be excluded if they had medical conditions and/or mental health problems requiring hospitalization. These conditions were excluded because stress relating to health conditions might confound research findings. After receiving ethics approval from institution review board (COA IRB-2019/526.0912), the researchers first contacted the school principal to seek permission to conduct the study. The sample size was calculated using power analysis. Based on required sample size calculated for pair t-test with a power of (p) 0.80, a significance level (α) = 0.05, medium effect size (d) = 0.5, and an attrition rate of 10%, yielding a prescribed sample of 30.

Intervention

The “MU-My-Mind Apps” is a prototype application, which was developed by multidisciplinary team based on user-centered approach. The application could be downloaded on Android mobile phones, which consisted of three systems. **System one** was a standardized screening system, containing self-reported questionnaires: the 18-item Psychological well-being scale (SPWB: Ryff et al., 1995), 21-item Depression Anxiety Stress Scale (DASS-21: Lovibond et al., 1995), and 15-item Mindfulness Scale (MAAS: Brown & Ryan, 2003). All three instruments had Cronbach alphas of .83, .93, and .88, respectively. **System 2** encompassed four-session mental health promotion program. It encompassed: a) “Breathe to relieve stress,” b) “Observing the body,” c) “Emotional awareness” and d) “Adjust your thoughts.....conquer the sadness”. Each session contained two major components: education and practice. **System 3** comprised a help need notification system.

From the students’ mobile screen, the “MU-My-Mind Apps” showed three core features including; a) personal information, b) standardized screening system, (3) mental health informational resources and d) mental health promotion program. The students were asked to install the “MU-My-Mind App” on their smart phone or tablet and then the researchers instructed them how to use the App. The first thing that they had to do after installing the application was to complete their personal information and then to fill up the screening tools. (Figure 1) They could view their screening results through the app, if they wished. Afterward, they needed to view each program session and follow its instructions. The program session will automatically run when the participants completes the required program session activities in each program session. The participants had to practice in each program session for three days. Then the program will automatically advance to the next program session. In overall, participants will be able to complete it within 1 month (Figure 2).

For the administration system, the researcher can see information about the progression of each student as well as their psychological health outcome results. The administrator can operate through web application.

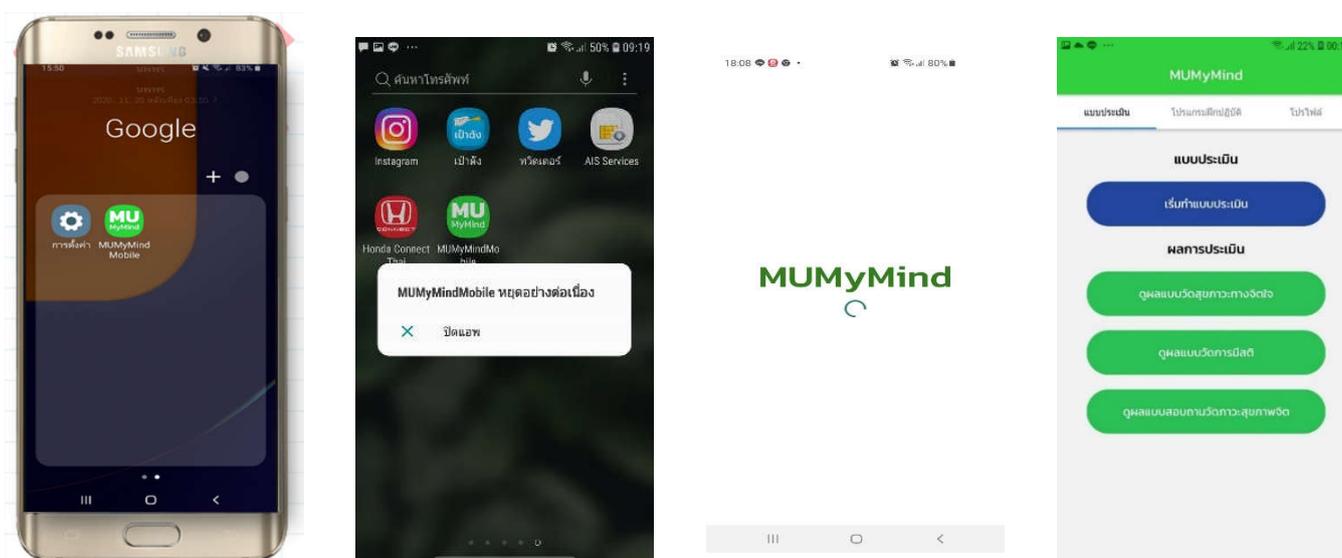


Figure 1.

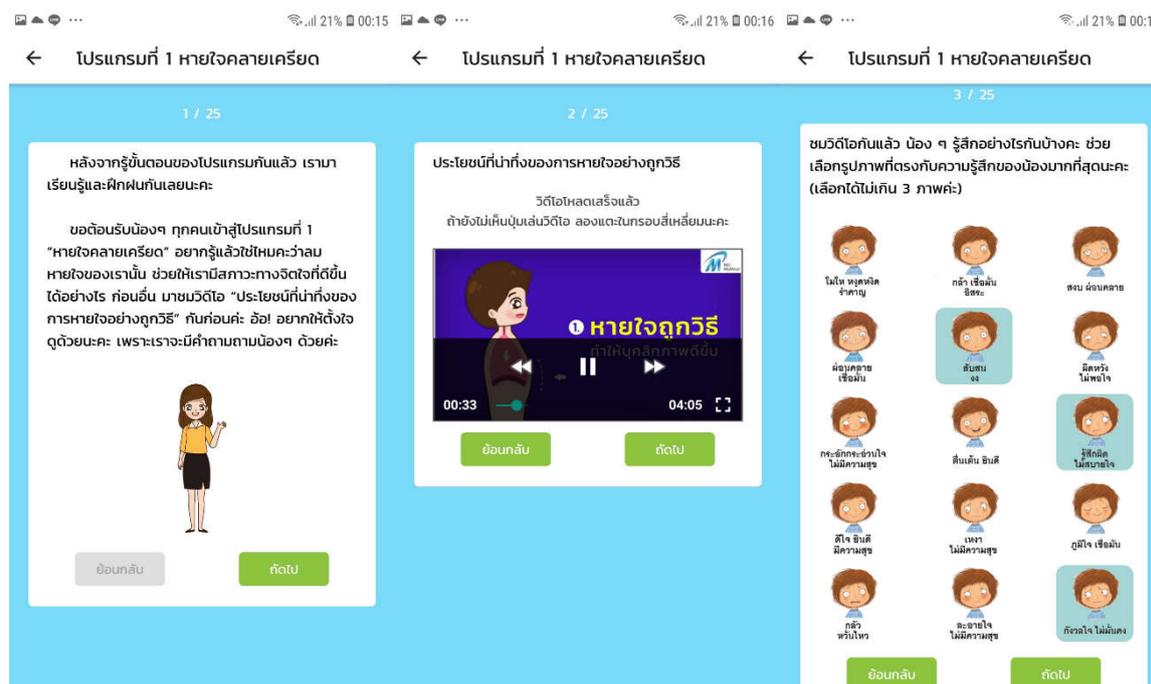


Figure 2. Sample screenshots of the program in “MU My Mind Mobile Application”.

Outcome measurement

The primary outcomes of the study were the feasibility and acceptability of the “MU My-Mind Mobile App” among Thai secondary school adolescents. The feasibility of the study was determined by rates of the application use (obtained from the program Analytics) and retention rate in the study. The acceptability was assessed by open-ended questions which were developed by the research team: “The questions include: How do the application help you to release stress?” and “What do like and dislike about the program?”

The secondary outcomes of this study included psychological well-being, mindfulness, depression, anxiety and stress. Psychological well-being was assessed by the 18-item psychological well-being scale (Ryff et al., 1995), which contain six dimensions including autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance. Students rated on the responses ranging from strongly agree (1) to strongly disagree (6). Internal consistency reliability was supported by Cronbach’s alphas in the range of 0.56-0.85 across four samples of adolescents in Singapore and Thailand (Klainin-Yobas et al., 2020).

Mindfulness was measured with the 15-item mindful attention awareness scale (MAAS) which reflects attention and awareness of what is occurring the current moment (Brown & Ryan, 2009). Response categories ranged from 1 (almost always) to 6 (almost never) and possible scores were in the range of 5 – 90. The highest scores signify the greatest levels of mindfulness. Validity of the scale was supported by its correlations with measures of mood disturbance and stress (Carlson & Brown, 2005). Cronbach’s alpha of the scale was 0.92, suggesting excellent reliability (Klainin-Yobas et al., 2022).

Depression anxiety and stress was determined by 21-item Depression Anxiety Stress Scale (DASS-21; Lovibond et al., 1995). The DASS-21 entails three subscales of questionnaire items, each of which contains seven items. Response categories ranged from 0 (did not apply to me at all) to 4 (apply to me most of the time). For each subscale, possible care ranged from 0 to 28 with the highest scores reflect the highest levels of each symptom. Cronbach’s alpha of the scale was 0.85, indicating good reliability (Klainin-Yobas et al., 2022).

Ethics

The present study was approved by the University Institution Review Broad)COA :No .IRB-NS2019/526.0912. (Eligible participants were informed about study objectives, intervention protocol,

benefits, risks, privacy and confidentiality of their information. Students were asked to signed a consent form and completed the baseline assessment. The issue of voluntary was emphasized and participants were informed that they could withdraw from study any time.

Statistical analysis

All statistical analyses were performed using Statistical Product and Service Solutions (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to summarize participant's characteristics, feasibility, and acceptability. Pair t-test were used to compare means between baseline and after intervention characteristics. A significant level was set at $\alpha = 0.05$. Thematic analyses were used for open-ended questions on acceptability of the MU-My-Mind App.

3. Results

Participant characteristics

A total of 30 participants completed the pre-posttest and none of them dropped out from the study. The students average age was 15.33 years old (SD = 1.97). Most students were female (66.7%, n=20) and Buddhist (93.3%, n=28); and all of them (100%, n=30) had GPA higher than 3.0 (out of 4.0) (Table 1).

Table 1. Baseline participant's characteristics (N =30.)

participant's characteristics	N (%)
age) year(mean) SD)	15.33 (1.97)
gender	
male	10 (33.3)
female	20 (66.7)
level of education	
Junior high school	14 (46.7)
High school	16 (53.3)
Grade point average (GPA)	
Lower than 3.00	-
Upper 3.00	30 (100.0)
Religion	
Buddhism	28 (93.3)
Christian	1 (3.3)
Islam	1 (3.3)

Acceptability of the "MU-My-Mind App"

After completion of the application, the students were asked to provide comments which can be summarized into six themes: a) Overall feedback of the program, b) Learning to manage stress and challenges, c) Elevating relaxation responses and calmness, d) Heightened mindfulness and concentration, e) Increased awareness and management of emotions, and f) Altering perspectives and managing thoughts. Furthermore, most comments are positive, suggesting that the application is well-accepted by the students.

Theme 1: Overall feedback to the program

Most participants complemented the Mu-My-Mind App was useful, smooth, user friendly, easy to understand and well-functioned. Videos were useful for daily living, interesting, cute, and easy to understand. Students learned about managing thoughts, emotion and stress.

"This program allows us to know about our own emotions. Sometimes we feel that emotions go before our thoughts. I listened to several video clips in the program in mobile application and I repeated it for 3 days, it allowed us to know what we were thinking. This thinking can come out to be a sentence. For example,

if we have feelings but we don't think, right? But when we know our feelings, we will say we're frustrated right now. We can stop our emotion. It makes us more conscious. I think this program is pretty good for people who don't want to consult a doctor" (P1, female)"

"Videos are easy to understand, interesting and very cute. I learned and improved myself in managing emotions. I had less mood swing and quarreled less with friends. Playing games helped me aware of my emotions" (P10, female).

"Thank you teachers for making this program for us. Given that we will be able to know our emotions., we will know ourselves. I think it really helps and I can see the results. I can confirm that it's ok. it really relieves my stress." (P6, female)

Theme 2: Learning to managing stress and challenges

Some participants mentioned that the application helped them manage stress in general and stress related to examinations. Furthermore, the program helped calm the body and increased awareness of self.

"I think the program is very good; however, there is a bug that need to be managed. Contents can be used to improved myself. In terms of stress management, I gave %100 satisfaction towards the programme)"P9, Male).

"Session two is very good as it makes us rest our mind and the body .Thinking about the body and our mind, which does not wander, make me calm down, not stress. Practicing mindful breathing helped clear my head, relaxed my body, and relieved stress when doing my homework.)"P5, Male)

Theme 3: Elevating relaxation responses and calmness

The first session of the program was perceived to be useful to many participants. The video guided them to practice mindful breathing, which helped them aware of the current moment, relax and calm down.

"I really liked the first session about "Breathe to relieve stress." I showed it to my friends, everyone instantly calmed down. The short video clip is good, not boring and it makes me wish to watch it.")P6, female.(

"The first session made me relaxed. Before the practice, the heart was beating fast. After the practice, the heart was more relaxed and I could sleep better" (P14, male).

Theme 4: Heightened mindfulness and concentration

Some participants testified that the mindful breathing helped increase concentration, focus on their tasks and control emotion. Such technique can be applied to daily activities.

"The first session makes me more mindful and control emotions better. I just broke up with my boyfriend. Practicing the first session helped me a lot. I wish that my friends can use it and practice it before taking examinations. That will help increase concentration" (P13, male).

"The program helped to perform meditation, making the mind less distracted. It is a systematic meditation that is practical, not just closing the eyes. It helped manage thoughts better and it can be integrated into daily activities, just like the video mentioned (P9, male)

Theme 5: Increased awareness and management of emotions

Most students felt that the Mu-My-Mind App helped them recognize and manage emotions better. They also learned about symptoms of depression and how to prevent it.

"[The program]..Helped me understand and manage my emotions better. I perceived my emotions more. When I was not in a good mood, I followed instruction guided by the videos. Then, I felt more relaxed and my mood became better quickly. The videos had contents that I have never seen before. I recognized my emotions and learned how to make myself into a better mood (P16, male)"

"The program made us know emotions. It is useful and makes know if we are at a risk of developing depression." (P3, female)

“Even the research project is completed, I wish that everyone can try the program because it contains a test to determine if we are depressed. If so, we can do practice to fix our problems. For me, the test showed that I am mildly and moderately depressed. Then, I am aware of my depression and I practice to manage my thoughts...positive thinking...do not think so much because that leads to poor mental health. Wish that everyone takes care of his/her mental health because there are news talking about stress every day.” (P29, male).

Theme 6: Altering perspectives and managing thoughts

The fourth session of the application addressed how to recognize and manage negative thoughts. Some participants appreciated the session and stated that it helped them aware of their own perspectives and changed some thoughts that are not useful.

“The contents of the videos in session 3 and 4 allowed us to know that our thought will depend on the point of view. What we think, it depends on our point of view. For example, I met a beggar, in the past, I might have thought that they are ugly and I might have walked away. But when I changed my perspective....They’re human being” (P2, 07)

“ I failed a chemistry exam. At first, I couldn’t take it., it was so sad. However, after I practiced in the program in mobile application. I could accept the failure. So, I regret it for only a short time)”P3,13(

“I’m quite satisfied, especially session 1, because I feel better after using it..... I’m a person who talks without thinking, causing problems with my friends. After practicing in the program in mobile application, when I am mad, then I told to myself that I can’t think of anything like this. I will stop and then I will breathe, then I can talk to my friends. ” (P4,02)

Feasibility of the “MU-My-Mind App”

Thirty students accessed the “MU-My-Mind App” and managed to completed all sessions of the program within four weeks. There were four sessions in the “MU-My-Mind App” encompassing; a) Breathe to relieve stress, b) Observing the body, c) Emotional awareness, and d) Adjust your thoughts.....conquer the sadness. In addition, students also managed to complete all pre- and post-tests with four weeks. All of this information suggested the feasibility of the “MU-My-Mind App”

Effects of the application on outcomes

Psychological well-being and Mindfulness

Results from t-test revealed that the MU-My-Mind App had the potential to improve psychological well-being among the students. Specifically, there was statistically significant difference between pretest (M=78.37; SD=9.34) and post-test scores) M=81.50, SD=12.26) ($t=-2.72$, $p=0.01$). Similarly, mindfulness levels at post-test (M=61.67; SD=10.34) were significantly higher than that at baseline assessment (M=65.07; SD=12.40) ($t=-2.98$, $p=0.01$).

Mental health problems, Depression, anxiety, and stress

The MU-My-Mind App had the potential to improve mental health problems, depression, anxiety and stress among secondary school students (Table 2). Particularly, there was a significant difference ($t=3.19$, $p<0.0001$) between pre-test (M=22.27, SD = 12.20) and post-test scores of mental health problems (M=17.77, SD = 13.90). Additionally, there were significant reductions in depression, anxiety and stress at post-intervention. Details are illustrated in Table 2.

Table 2. Comparisons of mean between pre-test and post-test across outcome variables) N=(30

	Pre test			Post test			<i>t</i>	<i>p</i>
	Mean	SD	SE	Mean	SD	SE		
Psychological Well-being	78.37	9.34	1.71	81.50	12.26	2.24	-2.72	0.01*
Mindfulness	61.67	10.34	1.89	65.07	12.40	2.26	-2.98	0.01*

	Pre test			Post test			<i>t</i>	<i>p</i>
	Mean	SD	SE	Mean	SD	SE		
Mental health problems	22.27	12.20	2.23	17.77	13.90	2.54	3.19	<0.001*
- depression	6.17	5.02	0.92	4.37	4.75	0.87	3.14	<0.001*
- anxiety	7.73	4.53	0.83	6.30	5.13	0.94	2.70	0.01
- stress	8.37	4.11	0.75	7.10	5.10	0.93	2.30	0.03*

4. Discussion

This feasibility study is the first attempt to develop the mobile application to promote psychological outcomes among secondary school students in Thailand and test its feasibility and acceptability. Our qualitative data suggested that the MU-My-Mind App was feasible with a 100% maintenance rate. Almost all students provided positive comments towards the application, indicating great acceptability. Based on quantitative data, following the completion of MU-My-Mind App, students reported significant improvements on mindfulness, psychological well-being, and mental health outcomes (depression, anxiety and stress).

In line with the primary outcomes of this study, the mobile platform was acceptable to the students. All functions available in the App were used, and benefits were reported as acceptable. It is possible that the main features of the MU-My-Mind App were designed based on the needs of students to enhance psychological health outcome problems they faced. Therefore, the MU-My-Mind App has potential to implement in the Thai secondary school students context. Similar to our findings, other pilot studies documented that a mobile application was a feasible solution for monitoring and optimizing mental health among adolescents (Rickard, Arjmand, Bakker & Seabrook, 2016; Williams & Pykett, 2022).

Findings concerning the acceptability of the MU-My-Mind derived into five themes: a) overall feedback of the program, b) learning to manage stress and challenges, c) elevating relaxation responses and calmness, d) heightened mindfulness and concentration, e) increased awareness and management of emotions, and f) altering perspectives and managing thoughts. Similarly, a qualitative study on adolescents in Chile highlighted the perceived effects of a mindfulness intervention (Langer et al., 2020). Specifically, participants addressed that practicing mindfulness improved problem-solving skills, re-signified negative experiences, increased attention and concentration, increased the feelings of body relaxation and sleep quality, enhanced greater sense of calm and well-being and help experience a sense of growth. The mechanism of action behind the mindfulness practice lied on the body awareness, which played a critical role in recognitions and regulations of cognition and emotions (Langer et al., 2020). The greater body awareness, the better the emotional and cognitive regulations (Langer et al., 2020).

Concerning the secondary outcomes, the MU-My-Mind App had the potential to improve all psychological outcomes. Our findings supported the psychological well-being model (Harding et al., 2019) in that the mindfulness-based intervention (via the mobile application) enhanced mindfulness (a protective factor) and PWB while minimized the negative effects of stress on the students. Therefore, the MU-My-Mind App can be regarded as a preventive intervention for mental health problems. Two possible mechanisms of mindfulness can be described here. First, mindful students were aware of their psychological problems, needs, and behaviors (Brown & Ryan, 2009). Therefore, they could seek help in the timely fashion, regulate their emotions and/or modify their behaviors to achieve more positive outcomes. Secondly, mindful students had cautious attention on their actions (Brown & Ryan, 2009) and; thus, they would feel grateful to all actions their perform in their daily lives.

Similarly, previous studies which explained that mindfulness partially mediated the effect of stress on psychological well-being (Vongsirimas et al., 2020). It is postulated that students who regularly practiced mindfulness perceived stress as non-threatening matters. Furthermore, students had an ability to self-regulate attention by shifting or decentering from the stress contents into the mode of current moment/activities that they were performing. They would focus on emotions and how they felt internally, rather than the external stressful situations. A stimulus which was appraised

initially as a threat, could be re-appraised as a non-threatening one. Reactions to stress were reduced by such re-appraisal, which led to reduced distress in the face of adversity (Vongsirimas et al., 2020; Vongsirimas, et al., 2009; Klainin-Yobas, P., et al., 2015).

There are certain limitations to this study that should be addressed .First, even though we calculated sample size to ensure that the sample size was sufficient, it is quite small which limited our ability to perform sophisticated statistical analyses .Also, the participants in this study were recruited from one school in Bangkok, Thailand which limited by the single-center nature and size of our study.

5. Conclusions

This feasibility study developed a mobile application, MU-My-Mind App, to promote psychological outcomes among adolescents in secondary school in Thailand and test its feasibility and acceptability. Our qualitative data suggested that the MU-My-Mind App was feasible to use and promote mental health in adolescent. Adolescents reported significant improvements in mental health outcomes (depression, anxiety and stress), mindfulness and psychological well-being. Therefore, the “MU My Mind Mobile Application” prototype was demonstrated as feasible and well-acceptable among Thai adolescents to promote their psychological health outcomes.

Author Contributions: Nopporn Vongsirimas planned the study, recruited the participants, performed data collection, analyzed the data, and writing—original manuscript. Sirada Kesornsri planned the study, recruited the participants, performed data collection, and analyzed the data. Phuangphet Kaesornsamut supervision and planned the study. Sudarat Pianchob review literature, recruited the participants and performed data collection. Wareerat Thanoi, Sathaka Pimroon, Supapak Phetrasuwan, Thineerat Thavorn review literature and performed data collection. Piyanee Klainin-Yobas analyzed the data and drafted the manuscript. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: This research conformed to the Declaration of Helsinki. It received approval and ethical clearance from the Institutional Review Board (IRB) of Mahidol University, Thailand (COA: No. IRB-NS2019/526.0912) before data collection. All procedures were conducted according to the IRB guidelines and regulations. Written informed consent was obtained from all participants involved in this study. A statement concerning ethics approval is included in this manuscript.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data is unavailable due to privacy and ethical restrictions from Institutional Review Board (IRB) of Mahidol University, Thailand.

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Conflicts of Interest: The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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