


PAPER

Mindfulness, Kindergarten, and Mobile Applications

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ABSTRACT

The following review explores the use of mobile applications in mindfulness practices. Also, it examines the fundamental characteristics of mobile applications that might enhance their effectiveness. This study is the third and final phase of a project that aims to investigate the advantages of technology and mindfulness in kindergarten. In the first two parts, we examined the use of social robots and virtual reality in mindfulness interventions. The objective of this paper is to present existing research on mobile applications and mindfulness, evaluate the possible advantages and obstacles of combining these two fields, and also analyze the features of the apps that lead to optimal results. We conducted a **bibliographic review of articles**. The results of our study indicate that mindfulness applications have a substantial impact on the development of children's mindfulness abilities, such as their ability to regulate attention and manage emotions, while also enhancing their general well-being. Advances in mobile technology provide opportunities to overcome barriers to traditional mindfulness training because they are portable devices that are also cost-effective. According to our findings, the apps should be **age-appropriate, simple, and engaging**. However, there is limited empirical evidence supporting the efficacy of many available mindfulness apps. We need further research to explore and validate their effectiveness, especially in comparison to traditional in-person interventions.

KEYWORDS

mobile applications, mindfulness, kindergarten

1 INTRODUCTION

Mindfulness-based interventions (MBIs) are generally known for improving well-being and quality of life [1]. "The conscious awareness that arises from intentionally focusing on the present moment, without judgment, while being fully engaged in the experiences, and maintaining an open and undistracted mind" is the typical description of mindfulness [2, 3]. According to multiple studies, MBIs seem to improve mental health by reducing symptoms of anxiety, depression, and stress. At the same time, they improve emotional regulation. These interventions have been associated with changes in the brain's networks that are responsible for

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executive functioning [3]. Regular meditation enhances emotional control, attention, and cognitive flexibility by fostering neuroplasticity [4].

Children who participated in the mindfulness programs demonstrated better academic achievements [5, 6]. Moreno-Gómez and Cejudo's [6] highlight the importance of early intervention for the promotion of well-being. Children's improved emotional regulation resulted in better stress and anxiety management. Also, the kids developed their social skills, which fostered better peer relationships [5]. Several studies emphasize the need to prioritize the implementation of MBIs for children [7].

Multiple authors emphasize the importance of integrating mindfulness practices into our daily routines because they claim that this aids the intervention's effectiveness [8]. However, there are some challenges, like the cost, time limitations, and the requirement for physical attendance, which prevent individuals from participating daily. These obstacles are particularly prevalent among young people and those living in rural areas. Christou, Tsermentseli, and Drigas [9] mention that mobile games have an important impact on metacognitive skills, such as self-awareness and self-regulation, through interactive and adaptable learning experiences. Recently, there has been a widespread availability of digital platforms for mindfulness training, such as mobile apps that are based on mindfulness techniques [3].

Drigas, Chaidi, and Papoutsis [10] emphasize the importance of integrating digital literacy, emotional intelligence, and adaptive learning methodologies into our teaching methods. Mrazek et al. [11] contend that the digital world plays a crucial role in the future of mindfulness training, providing innovative methods to enhance the accessibility and effectiveness of mindfulness. Embracing technology can be a catalyst for initiating and sustaining the practice of mindfulness [12].

Today, mindfulness has become very popular. This fact, combined with the widespread use of mobile devices, has led to a rapid increase in mobile applications specifically designed to provide mindfulness practice to the public [12]. The wide availability of mindfulness apps has prompted researchers to investigate the effects of fostering mindfulness through digital devices. Using apps for skill development has the potential to provide unique, engaging, and interactive learning experiences, especially among young individuals.

This paper addresses two key research questions: 1) Can mobile applications improve mindfulness training in kindergarten, and 2) What are the primary features of mobile applications that enhance their effectiveness in mindfulness training? The review begins by showcasing the mindfulness techniques and exercises currently employed in kindergartens. Next, it provides a series of systematic studies on the effects of mindfulness training on adults and the resulting outcomes. Afterwards, it explores the use of mobile applications in kindergartens, and finally, it defines the essential characteristics that mobile apps need to have in order to optimize their efficacy.

2 METHOD

This study offers an extensive review of various articles. Our aim was to examine the current understanding of the topic and identify potential gaps in the literature. We utilized databases such as Google Scholar, ResearchGate, and Mendeley, including only the studies published in English. The review was conducted using keywords such as "mobile applications," "mindfulness," and "kindergarten."

3 MINDFULNESS TECHNIQUES IN KINDERGARTEN

Mindfulness is more than just meditation, breathing exercises, or relaxation techniques. Meditation aids in the development of mindfulness [13, 14], while mindfulness practice incorporates breathing exercises [12]. There are multiple activities specifically created to foster mindfulness, which improve self-observation, self-awareness, and body awareness [15]. Kabat-Zinn created a course known as mindfulness-based stress reduction, teaching individuals' various techniques to cultivate mindfulness, such as focused attention exercises, body scans, breathing exercises, and yoga-based activities [16]. An effective technique is to sit in a comfortable position, close the eyes, and focus on the breath sensations without trying to control them. Body scan meditation involves directing one's attention to various body areas and observing the sensations that are present. Additional techniques encompass engaging in yoga with a mindful focus on physical motions and sensations, as well as participating in walking meditation [17].

Britton and Sydnor [4] examine two mindfulness techniques that help the development of executive functions. Focused attention (FA) is the name of the first technique. In this technique, the practitioner deliberately directs and maintains attention on a specific thing, like the breath, a visual object, or a sound, while at the same time ignoring other stimuli. All the other thoughts, emotions, and body sensations that aren't the focus of meditation are considered distractions. On the other hand, open-monitoring (OM) practice involves continuously observing all kinds of stimuli, like thoughts, emotions, body sensations, and sounds, without actually prioritizing any.

Between the ages of three and seven, there is notable development of the prefrontal cortex, allowing for the acquisition of advanced cognitive skills such as executive functioning, effortful control, theory of mind, and empathy. These skills are essential for self-regulation [18]. Sun et al. [19] conducted a systematic review that provided evidence of the potential benefits of yoga and mindfulness in enhancing social and emotional development in preschool-aged children.

Research has found that mindfulness training enhances the development of self-regulation in young children, encompassing cognitive, emotional, and behavioral regulation. Moreover, these programs may provide academic advantages. Research indicates that mindfulness training can be especially advantageous for children facing additional challenges related to their economic status, home environment, temperament, behavior, or cognitive abilities. These children consistently showed the most significant improvement from MBI programs [18].

Schools can incorporate meditation practices into their curricula to improve the overall well-being and academic performance of students [4]. Shonin, Van Gordon, and Griffiths [20] analyze strategies for teaching mindfulness in schools. Firstly, the techniques should be age-appropriate, and the sessions must be short. The curriculum can incorporate these practices to enhance learning, concentration, and emotional control. Finally, it is critical that the activities be both creative and engaging, such as mindful breathing exercises, body scans, or mindful movement activities like yoga, in order to effectively teach mindfulness skills [20]. The following are three studies that implemented mindfulness techniques in kindergarten settings.

Sciotto et al. [21] investigated the impact of a school-implemented mindfulness program on young children. The study introduced a systematic mindfulness curriculum in schools that consisted of customized activities and practices specifically created for young children. The findings showed improvements in children's

behavior, including reduced disruptive behaviors and improved social abilities. The curriculum included developmentally appropriate tasks such as breathing exercises, mindful listening, and guided relaxation, which teachers included in their regular routines. The findings indicate that implementing mindfulness programs in schools may benefit the school environment and promote students' social and emotional growth.

The study by Lee et al. [14] investigated the impact of an intervention combining unstructured free play and mindfulness practices on the well-being of kindergarten students. Forty-two children aged four to six from Hong Kong participated in the study. The intervention consisted of unstructured play, followed by a mindfulness intervention lasting 10 minutes per day. The study investigated the impact of these activities on the emotional, social, and cognitive development of children. The results imply that the integration of unstructured play and mindfulness in early childhood education is a useful technique that greatly enhances different elements of wellbeing in young children [14].

De Greiff [22] examined the impact of a daily five-minute meditation program in a kindergarten classroom. Through this technique, the author saw improvements in the children's focus and behavior. The mindfulness therapies included techniques such as present-moment awareness, meditation, physical activation, thankfulness, and kindness. Following the intervention, the children's behavior underwent significant positive changes: they exhibited a calmer demeanor both inside and outside the classroom, became kinder to each other, and began to recognize acts of kindness around them. This study demonstrated the integration of mindful practices into the traditional educational teaching model [22].

4 MOBILE APPLICATIONS AND MINDFULNESS

In this subsection, we present some systematic research and reviews about the use of mobile apps in mindfulness interventions.

Schwartz, Ganster, and Tran [23] conducted an extensive review of the effectiveness of mindfulness-based mobile applications on the well-being of nonclinical populations. According to their review, these applications have a positive impact on well-being, stress reduction, emotional regulation, and overall mental health. Headspace is the most popular app among them, with more than 20 million downloads and the highest score on the Mobile Application Rating system [23]. This application offers daily guided meditations led by Andy Puddicombe, a former Buddhist monk. Studies have shown that using this app can result in several advantages, such as enhanced awareness, mindfulness, and well-being [3].

Economides et al. [3] conducted a study to evaluate the potential of a short mindfulness intervention offered by Headspace for reducing stress levels, emotional effects, and irritation. They assessed the levels of stress and irritation both before and after the intervention. The participants were 69 individuals, ranging in age from 18 to 50 years old. The findings revealed that a brief MBI delivered through the application successfully reduced stress and irritation and improved the mood [3].

Flett et al. [24] investigated the efficacy of two commonly utilized mobile mindfulness meditation applications, Headspace and Smiling Mind, in comparison to a "placebo" application, Evernote, in relation to mental health. They subjected university students, aged 18 to 49, to pre- and post-intervention evaluations to assess any alterations in mental health outcomes. The study revealed that the utilization of

mindfulness apps had a beneficial effect on mental health, resulting in heightened awareness, less depression and anxiety, and enhanced general well-being.

Huberty et al. [25] conducted a randomized controlled trial to evaluate the efficacy of the mindfulness meditation application “Calm” in reducing stress levels among college students. The researchers divided the participants into two groups. The first group used the “Calm” app, and the second one was the control group. The findings of the study indicated that students who utilized the “Calm” application exhibited a significant decrease in stress levels in comparison to individuals in the control group. The study’s findings suggest that mobile applications such as “Calm” can be an easily available tool for college students to reduce stress. These apps can also be efficient tools in mindfulness training [25].

Duraimani [26] examined if a mobile application for mindfulness meditation can reduce stress and anxiety levels in users. The study involved the development of a meditation software named “Aware,” which included core training on mindfulness meditation practices. They used Kabat-Zinn’s mindfulness meditation to create a structured guided session and investigated the immediate impact of using apps on participants’ stress and anxiety levels. The results linked the use of the “Aware app” to immediate decreases in stress and anxiety [26].

Golec de Zavala et al. [27] investigated if a mobile-app-supported mindfulness training program can provoke changes in the daily mood of the users. The study required daily monitoring of the participants to ensure its accuracy. The findings indicated overall mood improvements throughout the program. Similarly, Howells [28] evaluated the effectiveness of a smartphone app-based application that aimed to enhance happiness and well-being. This intervention included activities and exercises such as daily prompts, gratitude exercises, and mindfulness practice. They all aimed to boost happiness, cultivate positive emotions, and lessen stress. The study found significant improvements in happiness and well-being among participants in the intervention group compared to those in the control group.

Mitsea, Drigas, and Skianis [29] conducted a comprehensive analysis that specifically examined the utilization of digitally assisted mindfulness techniques to improve self-regulation abilities for the purpose of maintaining long-term mental well-being. In their study, they mention SERMO, an AI smartphone application that successfully utilized a chatbot to integrate mindfulness training and cognitive behavior therapy. Its purpose is to assist individuals with mental health issues in managing their emotions and addressing their thoughts and feelings [29]. They also mention Wysa, an AI bot that uses empathy and interaction to provide digital mindfulness training. The app utilizes written and structured conversations to accurately detect users’ emotions and provide therapeutic self-regulation techniques. The app derives these strategies from mindfulness, cognitive behavioral therapy, and positive psychology techniques.

Carissoli, Villani, and Riva [30] studied and evaluated the efficacy of the mobile application “It’s time to relax.” 56 Italian workers participated in the study, either as an intervention group using the meditation application or as a control group. The study revealed that individuals in the intervention group had a decrease in their perceived stress levels. Schultchen et al. [8] conducted a thorough review of mindfulness applications that are accessible in European app stores. They created a consistent grading scale to assess the apps based on characteristics like usability, content quality, evidence base, and user engagement features. The common strengths of the apps were user-friendly interfaces, structured mindfulness exercises, and the inclusion of tracking and feedback mechanisms. On the other hand, common weaknesses included a lack of personalized content and limited scientific evidence of effectiveness.

5 MOBILE APPLICATIONS AND KINDERGARTEN

Early exposure to mobile phones and ICTs has familiarized students with these devices [31]. However, it is critical that parents understand the importance of their role in fully utilizing digital tools for their own benefit, particularly in enhancing emotional and cognitive development [32].

Nunes, Castro, and Limbo [12] evaluated certain mobile mindfulness applications designed for children. Most of these apps featured audio-based meditation exercises, often accompanied by videos. MARS (Mobile Application Rating Scale) is a tool that assesses engagement, functionality, aesthetics, and information quality. So, according to their findings, despite generally achieving an “acceptable” level of quality, most apps did not score well across all dimensions of the MARS [8]. Nunes, Castro, and Limbo [12] highlighted the most downloaded and highest-rated apps in their study. As previously mentioned, Headspace remains the most downloaded and extensively researched mobile application. Here, we will provide a brief overview of several other popular mindfulness apps for kids.

- **GoNoodle – Kid Movement and Mindfulness Videos:** Its goal is to promote physical activity among children by encouraging them to move throughout the day. It offers videos and free activities specifically targeting young students.
- **Mindfulness with Petit BamBou:** guided meditation and breathing exercises
- **Align Mindfulness:** This app sends brief prompts as notifications. Once the user receives this message, he has the option to choose how to proceed. For instance, he can write a response or just take a moment to reflect on the prompt before continuing. The goal of the app is to focus on the present moment.
- **Cosmic Kids Yoga:** guided yoga lessons tailored for children aged three years and older.
- **Serenity:** Guided meditation offered a range of mindfulness techniques categorized into various levels of difficulty [12].

Unfortunately, we didn't find systematic reviews evaluating the effectiveness of the above applications.

Nicolaidou et al. [33] aimed to assess if a gamified application specifically designed for children can actually help them manage their stress. The name of the app is “Kids’ Stress Relief,” and the current version includes five short stories. The main goal of these stories is to help children recognize and understand emotions such as happiness, sadness, and anger. It also aims to teach them effective anger management, empathy, and the recognition of physical signs of stress. Additionally, it emphasizes in teaching strategies for dealing with stress from common stressors, such as test anxiety, fear of thunderstorms, and meeting new people. The study found that children under the age of seven interacted with the breathing exercises passively, following instructions without actively participating in the stress-relieving techniques intended by the app developers [33].

Treves et al. [34] investigated the impact of a mobile application-based mindfulness intervention at home on children’s well-being. The study conducted a comparison between the results of youngsters who utilized the mindfulness application and those who engaged in alternative active control activities. The findings indicated that children who used the mindfulness app showed significant improvements in emotional regulation, concentration, and stress reduction compared to the control group [34]. In general, it seems that there is room for

improvement in the current mindfulness applications developed specifically for children [12].

6 MOBILE APPLICATIONS ADVANTAGES AND CHARACTERISTICS

6.1 Advantages

Mobile devices facilitate the efficient and successful implementation of digital technology in education, allowing for the execution of evaluation, intervention, and educational procedures in any location [35]. Introducing a digital approach to mindfulness training has the potential to offer several benefits, such as improved accessibility, standardization, individualization, and effectiveness [11]. Research findings suggest that we can scale mindfulness interventions delivered via mobile apps to reach a wider audience, providing mental health support in situations where in-person sessions are impractical [2]. They also indicate that mobile app-based interventions are easily accessible and cost-effective [2], offering systematic and proactive education to the general public, thus overcoming economic and social barriers [36].

By integrating audio and visual information, technology-based mindfulness training appears to assist children and adolescents in better grasping abstract concepts related to practicing mindfulness strategies [12]. Compared to traditional face-to-face settings, using apps is more cost-effective and requires fewer resources. Furthermore, the portability of mobile devices allows users to participate in mindfulness practice at any location and at any time [12]. Mobile applications are also more captivating and require less time [3]. These resources enable flexibility in terms of their usage time and location, have broad accessibility, have reminder functionalities, and offer additional materials such as images and videos [8].

6.2 Limitations

However, mindfulness applications have several limitations, including insufficient data protection and privacy features, as well as consent issues. Furthermore, it is necessary to investigate the efficacy of teaching stress relief techniques to children aged four to 12 exclusively through the use of apps without any prior involvement from instructors or parents [33]. Although young children may quickly become proficient in using technology, they often face difficulties such as unintentionally swiping, tapping incorrectly, or mistakenly exiting the application. As a result, parents or caregivers must supervise their use of technology [12]. According to Chaidi et al. [1], it is advantageous to use hybrid models that integrate both in-person and telehealth sessions.

6.3 Recommended features

It's important to point out that mobile application use generally declines within the first 90 days of installation [25]. Hence, we thought it was imperative to include in our study a few guidelines for future mindfulness-app designers.

Firstly, mindfulness interventions designed for children require clear instructions and short activities; they should incorporate metaphors and images; they should use

movement-based exercises; and they should offer a balance of silent, inquiry-based, and interactive activities. Designing apps for children also necessitates specific usability considerations [12], such as avoiding excessive navigation, scrolling, and advertisements, employing simple actions, incorporating animations and sounds, using age-appropriate and interactive designs, and ensuring entertainment value.

Furthermore, timers, reminders, meditation guides, and relaxation exercises can augment both the level of involvement and the efficacy of mindfulness practice [17, 23]. Studies indicate that these functions frequently result in higher user ratings [8]. In addition, it is essential for mindfulness applications to provide a clear and comprehensive explanation of the theory and techniques of mindfulness while also addressing prevalent misunderstandings [17, 37].

In the end, applications should encourage regular use and create a sense of confidence in users. Currently, there is a lack of applications specifically tailored for professionals or individuals who participate in long-term meditation. Lastly, developing applications in languages other than English can enhance accessibility for non-English-speaking users [37].

7 RESULTS AND DISCUSSION

This paper aims to address two research questions:

1. Can mobile applications improve mindfulness training in kindergarten?
2. What are the primary features of mobile applications that enhance their effectiveness in mindfulness training?

The literature review reveals that well-designed mindfulness applications significantly enhance children's mindfulness abilities. This includes improving their attention regulation, managing their emotions, and overall well-being. The use of mobile applications for mindfulness practice is becoming more widespread. Similarly, research has shown that adults who receive mindfulness training through mobile apps experience improvements in their quality of life, self-reported mindfulness, and depression symptoms reduction. The latest progress in mobile app technology presents a favorable chance to address several obstacles linked to traditional mindfulness training. Moreover, the portability of mobile phones might alleviate geographical, social, and economic barriers to access.

Regarding our second research question, it is essential to create age-appropriate and engaging digital content for mindfulness if our aim is to maximize its effectiveness and appeal. Only by customizing the content and aligning it with the children's developmental stages and interests will the mindfulness apps catch their attention and, therefore, maintain it. Based on this study's findings, we propose the following recommendations for future mindfulness apps:

1. The app should provide the theoretical basis and explanations for mindfulness.
2. Prioritize robust data protection measures and ensure a child-friendly interface that avoids distractions like advertisements.
3. The instructions must be simple, easy to follow, and the activities short.
4. The design is easy to navigate, attractive, user-friendly, and age-targeting.
5. Simple actions and animations, engaging visuals, and interactive features all contribute to entertaining elements.

6. There should be reminders for practice and progress tracking features.
7. Develop apps in multiple languages to reach diverse populations.

The purpose of these proposals is to improve the design and features of future mindfulness applications, with the aim of making them more effective tools for promoting mindfulness in children. Moreover, these characteristics enhance the app's appeal, thereby raising the probability of consistent usage and long-term benefits.

8 CONCLUSIONS

Mindfulness can improve concentration, emotional control, and overall psychological well-being. Previous research has demonstrated that therapies using mobile technology in real-time have successfully improved health outcomes in different areas, including anxiety and stress management. Mobile applications have the ability to promote a healthy lifestyle, hence facilitating the implementation of more personalized therapies. Mindfulness-focused apps have the potential to improve mindfulness skills and support the emotional development of children. Using mobile applications to provide structured interventions can increase the accessibility of mindfulness programs to young people living in rural areas, who may otherwise have limited access.

The research on the efficacy of mobile applications that use mindfulness practices is currently in its early stages. Although there are numerous mindfulness applications available, a significant number of them lack empirical data to support their effectiveness. Thus, although it provides a cost-effective alternative to traditional mindfulness training, it is important to be cautious due to the low amount of supporting evidence. Although there is a large range of mindfulness apps available, their quality and usefulness might differ significantly. Digital interventions via apps are assumed to be advantageous; however, few studies compare their effectiveness with face-to-face interventions in children, and little is known about children's ability to independently use mindfulness apps effectively.

9 REFERENCES

- [1] N. Chadi, E. Weisbaum, D. X. Vo, and S. Ahola Kohut, "Mindfulness-based interventions for adolescents: Time to consider telehealth," *J. Altern. Complement. Med.*, vol. 26, no. 3, pp. 172–175, 2020. <https://doi.org/10.1089/acm.2019.0302>
- [2] A. Golec de Zavala, O. Keenan, M. Ziegler, P. Ciesielski, J. E. Wahl, and M. Mazurkiewicz, "App-based mindfulness training supported eudaimonic wellbeing during the COVID19 pandemic," *Appl. Psychol. Heal. Well-Being*, vol. 16, no. 1, pp. 42–59, 2024. <https://doi.org/10.1111/aphw.12468>
- [3] M. Economides, J. Martman, M. J. Bell, and B. Sanderson, "Improvements in stress, affect, and irritability following brief use of a mindfulness-based smartphone app: A randomized controlled trial," *Mindfulness*, vol. 9, pp. 1584–1593, 2018. <https://doi.org/10.1007/s12671-018-0905-4>
- [4] W. Britton and A. Sydnor, "Neurobiological models of meditation practices: Implications for applications with youth," in *Teaching Mindfulness Skills to Kids and Teens*, C. Willard and A. Saltzman, Eds., New York: The Guilford Press, 2015, pp. 402–414.

- [5] A. Moreno-Gómez, P. Luna, and J. Cejudo, "Promoting school success through mindfulness-based interventions in early childhood," *Rev. Psicodidáctica*, vol. 25, no. 2, pp. 136–142, 2020. <https://doi.org/10.1016/j.psicoe.2019.12.001>
- [6] A. J. Moreno-Gómez and J. Cejudo, "Effectiveness of a mindfulness-based social-Emotional learning program on psychosocial adjustment and neuropsychological maturity in kindergarten children," *Mindfulness*, vol. 10, pp. 111–121, 2019. <https://doi.org/10.1007/s12671-018-0956-6>
- [7] N. N. Singh and S. D. S. Joy, "Mindfulness-based interventions with children and adolescents," in *Mindfulness-based Interventions with Children and Adolescents*. London: Routledge, 2021, pp. 3–9. <https://doi.org/10.4324/9781315563862-2>
- [8] D. Schultchen *et al.*, "Stay present with your phone: A systematic review and standardized rating of mindfulness apps in European app stores," *Int. J. Behav. Med.*, vol. 28, pp. 552–560, 2021. <https://doi.org/10.1007/s12529-020-09944-y>
- [9] A. I. Christou, S. Tsermentseli, and A. Drigas, "The role of mobile games and environmental factors in improving learning and metacognitive potential of young students," *Int. J. Interact. Mob. Technol. (ijIM)*, vol. 17, no. 18, pp. 67–84, 2023. <https://doi.org/10.3991/ijim.v17i18.42437>
- [10] A. Drigas, I. Chaidi, and C. Papoutsis, "The teacher of the future," *Int. J. Emerg. Technol. Learn. (ijET)*, vol. 18, no. 16, pp. 87–114, 2023. <https://doi.org/10.3991/ijet.v18i16.36169>
- [11] A. J. Mrazek *et al.*, "The future of mindfulness training is digital, and the future is now," *Curr. Opin. Psychol.*, vol. 28, pp. 81–86, 2019. <https://doi.org/10.1016/j.copsyc.2018.11.012>
- [12] A. Nunes, S. L. Castro, and T. Limpo, "A review of mindfulness-based apps for children," *Mindfulness*, vol. 11, pp. 2089–2101, 2020. <https://doi.org/10.1007/s12671-020-01410-w>
- [13] M. F. Perrier, N. Gurgel-Juarez, H. L. Flowers, A. McCormick, and S. J. Short, "Mindfulness-based interventions for children and adolescents across all settings: A scoping review protocol," *Syst. Rev.*, vol. 9, 2020. <https://doi.org/10.1186/s13643-020-01548-7>
- [14] R. L. T. Lee *et al.*, "Effects of an unstructured free play and mindfulness intervention on wellbeing in kindergarten students," *Int. J. Environ. Res. Public Health*, vol. 17, no. 15, p. 5382, 2020. <https://doi.org/10.3390/ijerph17155382>
- [15] I. Moraiti, A. Fotoglou, and A. Drigas, "Mindfulness training – effect on adults with ADHD and depressive symptoms and the role of digital technologies," *J. Heal. Technol. – JHT*, vol. 2, no. 3, pp. 1–18, 2023. <https://doi.org/10.47820/jht.v2i3.39>
- [16] J. Laurie and A. Blandford, "Making time for mindfulness," *Int. J. Med. Inform.*, vol. 96, pp. 38–50, 2016. <https://doi.org/10.1016/j.ijmedinf.2016.02.010>
- [17] M. Mani, D. J. Kavanagh, L. Hides, and S. R. Stoyanov, "Review and evaluation of mindfulness-based iPhone apps," *JMIR mHealth uHealth*, vol. 3, no. 3, p. e82, 2015. <https://doi.org/10.2196/mhealth.4328>
- [18] J. O. Bockmann and S. Y. Yu, "Using mindfulness-based interventions to support self-regulation in young children: A review of the literature," *Early Childhood Education Journal*, vol. 51, pp. 693–703, 2023. <https://doi.org/10.1007/s10643-022-01333-2>
- [19] Y. Sun, R. Lamoreau, S. O'Connell, R. Horlick, and A. N. Bazzano, "Yoga and mindfulness interventions for preschool-aged children in educational settings: A systematic review," *International Journal of Environmental Research and Public Health*, vol. 18, no. 11, p. 6091, 2021. <https://doi.org/10.3390/ijerph18116091>
- [20] E. Shonin, W. Van Gordon, and M. D. Griffiths, "Practical tips for teaching mindfulness to children and adolescents in school-based settings," *Educ. Heal.*, vol. 32, no. 2, pp. 69–72, 2014.
- [21] M. J. Sciutto, D. A. Veres, T. L. Marinstein, B. F. Bailey, and S. K. Cehelyk, "Effects of a school-based mindfulness program for young children," *J. Child Fam. Stud.*, vol. 30, pp. 1516–1527, 2021. <https://doi.org/10.1007/s10826-021-01955-x>

- [22] I. E. A. de Greiff, "Using mindful classroom strategies to improve behavior and cognitive development in kindergarten students," in *Mindful Learning: Research on Learner Awareness, Metacognition, and Learning Strategies Voices from the Field: Research from the Specialist Program in Bilingual Education*, J. Taylor, Ed., Bogotá: Institución Universitaria Colombo Americana – ÚNICA, 2020, pp. 214–230.
- [23] K. Schwartz, F. M. Ganster, and U. S. Tran, "Mindfulness-based mobile apps and their impact on well-being in nonclinical populations: Systematic review of randomized controlled trials," *J. Med. Internet Res.*, vol. 25, p. e44638, 2023. <https://doi.org/10.2196/44638>
- [24] J. A. M. Flett, H. Hayne, B. C. Riordan, L. M. Thompson, and T. S. Conner, "Mobile mindfulness meditation: A randomised controlled trial of the effect of two popular apps on mental health," *Mindfulness*, vol. 10, pp. 863–876, 2019. <https://doi.org/10.1007/s12671-018-1050-9>
- [25] J. Huberty, J. Green, C. Glissmann, L. Larkey, M. Puzia, and C. Lee, "Efficacy of the mindfulness meditation mobile app 'calm' to reduce stress among college students: Randomized controlled trial," *JMIR mHealth uHealth*, vol. 7, no. 6, p. e14273, 2019. <https://doi.org/10.2196/14273>
- [26] S. Duraimani, "A cross-sectional and longitudinal study of the effects of a mindfulness meditation mobile application platform on reducing stress and anxiety," *Int. J. Yoga*, vol. 12, no. 3, pp. 226–232, 2019. https://doi.org/10.4103/ijoy.IJOY_56_18
- [27] A. Golec de Zavala, C. Förster, M. Ziegler, M. Nalberczak-Skóra, P. Ciesielski, and M. Mazurkiewicz, "The shape of the change: Cumulative and incremental changes in daily mood during mobile-app-supported mindfulness training," *Appl. Psychol. Heal. Well-Being*, vol. 18, no. 3, pp. 1122–1140, 2024. <https://doi.org/10.1111/aphw.12518>
- [28] A. Howells, I. Ivtzan, and F. J. Eiroa-Orosa, "Putting the 'app' in happiness: A randomised controlled trial of a smartphone-based mindfulness intervention to enhance wellbeing," *Journal of Happiness Studies*, vol. 17, pp. 163–185, 2016. <https://doi.org/10.1007/s10902-014-9589-1>
- [29] E. Mitsea, A. Drigas, and C. Skianis, "Digitally assisted mindfulness in training self-regulation skills for sustainable mental health: A systematic review," *Behav. Sci.*, vol. 13, no. 12, p. 1008, 2023. <https://doi.org/10.3390/bs13121008>
- [30] C. Carissoli, D. Villani, and G. Riva, "Does a meditation protocol supported by a mobile application help people reduce stress? Suggestions from a controlled pragmatic trial," *Cyberpsychology, Behav. Soc. Netw.*, vol. 18, no. 1, pp. 46–53, 2015. <https://doi.org/10.1089/cyber.2014.0062>
- [31] V. Galitskaya and A. S. Drigas, "Mobiles & ICT based interventions for learning difficulties in geometry," *Int. J. Eng. Pedagog.*, vol. 13, no. 4, pp. 21–36, 2023. <https://doi.org/10.3991/ijep.v13i4.36309>
- [32] A. Drigas, M. Karyotaki, and C. Skianis, "Mobiles, digital tech, empathy, metacognition, self-consciousness and the role of parents in schools and societies of the future," *Int. J. Interact. Mob. Technol.*, vol. 17, no. 7, pp. 118–132, 2023. <https://doi.org/10.3991/ijim.v17i07.37201>
- [33] I. Nicolaidou, F. Tozzi, P. Kindynis, M. Panayiotou, and A. Antoniadis, "Development and usability of a gamified app to help children manage stress: An evaluation study," *Ital. J. Educ. Technol.*, vol. 27, no. 2, pp. 105–120, 2019. <https://doi.org/10.17471/2499-4324/1050>
- [34] I. N. Treves et al., "At-home use of app-based mindfulness for children: A randomized active-controlled trial," *Mindfulness*, vol. 14, pp. 2728–2744, 2023. <https://doi.org/10.1007/s12671-023-02231-3>
- [35] A. M. Driga, A. Zavitsanou, and A. Drigas, "Negative impacts of 15 white foods on health and brain and the role of mobiles in healthy living education," *J. Heal. Technol. – JHT*, vol. 2, no. 2, p. e2235, 2023. <https://doi.org/10.47820/jht.v2i2.35>

- [36] M. Karyotaki, A. Drigas, and C. Skianis, “Mobile/VR/Robotics/IoT-based chatbots and intelligent personal assistants for social inclusion,” *Int. J. Interact. Mob. Technol.*, vol. 18, no. 8, pp. 40–51, 2024. <https://doi.org/10.3991/ijim.v18i08.46473>
- [37] I. Plaza, M. M. P. Demarzo, P. Herrera-Mercadal, and J. García-Campayo, “Mindfulness-based mobile applications: Literature review and analysis of current features,” *JMIR mHealth uHealth*, vol. 1, no. 2, p. e24, 2013. <https://doi.org/10.2196/mhealth.2733>

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