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The future of mindfulness training is digital, and the future is now☆

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Digital mindfulness-based interventions (d-MBIs) present a promising path for the scalable dissemination of mindfulness instruction in the 21st century. Smartphone applications and web-based platforms can offer potential advantages over traditional face-to-face formats through enhanced accessibility, standardization, personalization, and efficacy of mindfulness training. A growing body of research has documented that a digital approach to teaching mindfulness can improve measures of attention, stress, depression, and anxiety. However, effective digital mindfulness instruction must overcome a variety of challenges, including the possibility of low engagement, shallow learning, and unaddressed obstacles or frustrations. Fortunately, best practices from multiple fields of research provide strategies to overcome these challenges.

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Since mindfulness apps began circulating in 2007, digital mindfulness training has reached millions of people all over the world [1,2]. There are now thousands of mindfulnessapps on the market, and these apps attracted more than $150 million of venture capital in 2017 alone [1,3]. Traditional face-to-face programs like Mindfulness-Based Stress Reduction are also being turned into e-courses, while digital mindfulness teacher training programs are growing in popularity as well [4,5]. This meteoric rise of digital mindfulness-based interventions (d-MBIs) presents an unprecedented opportunity to deliver high-quality training to an increasingly internet-connected global audience. Here we review the promise, existing research, challenges, and best practices for this new era of mindfulness training.

Promise

There are several potential advantages to a digital approach to mindfulness training, including enhanced accessibility, standardization, personalization, and efficacy.

Accessibility

A key benefit of d-MBIs is that they can reduce geographical, logistical, and financial constraints that would otherwise prevent access to high quality training [6,7]. Users also report enjoying the greater accessibility and scheduling flexibility of digital training [6,8]. In one study, users of a d-MBI reported that the training's accessibility facilitated their engagement by allowing them to access it across devices and at the times of their choosing [9•].

Standardization

Even a great curriculum can fail to provide benefits if it is delivered ineffectively. Digital training provides the opportunity to standardize key elements of course content and presentation, thereby ensuring that all users receive the same high-quality instruction [10,11].

Personalized learning

Digital training can also provide content that is tailored to the abilities, interests, and values of individual users. For example, d-MBIs can provide users with immediate personalized feedback, which is challenging to achieve in traditional classrooms with many students [10,12]. Overall, a personalized approach that tailors the curriculum to individual students has been shown to heighten both engagement and learning outcomes [12,13].

Efficacy

Although one might assume that in-person instruction would produce superior learning outcomes, research

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suggests that well-designed digital training can elicit equal or even greater outcomes [8,12,14]. For instance, one comparative study found that both d-MBI's and face-to-face mindfulness interventions were equally effective in helping reduce perceived levels of depression, anxiety, and stress [15].

Existing research

A large and growing body of research suggests that face-to-face mindfulness interventions can lead to a myriad of benefits [16]. Can strictly digital MBIs that lack face-to-face interaction deliver benefits as well? Although much less research exists, here we provide a brief review of recent research into the effects of d-MBIs on three categories of outcomes: first, mindfulness and attention, second, stress, and third, depression and anxiety.

Mindfulness

Stjernsward & Hansson [17] administered a d-MBI to 97 individuals experiencing distress due to a mental illness in their family. The eight-week course was adapted from the standard MBSR training protocol and included a total of 960 minutes of mindfulness practice. Completion of the intervention was associated with a significant increase at post-test and 3-month follow up in the Acting with Awareness subscale of the Five Facet Mindfulness Questionnaire (FFMQ; e.g. *"I find myself doing things without paying attention"*; reverse coded).

Shore *et al.* [18•] delivered a much less intensive d-MBI to 110 university students. After completing just an hour-long introduction to mindfulness, participants reported improvements on the Acting with Awareness subscale of the FFMQ at post-test and 1-week follow up assessments. Noone and Hogan [19] reported a similar increase in their participants' scores on the FFMQ following a brief d-MBI.

Kemper [20] also investigated the effects of a one-hour d-MBI among health professionals. Completion of the module was associated with significant improvements on the Mindfulness Attention Awareness Scale (MAAS). Participants who engaged in a four-week d-MBI using the mobile phone application Headspace reported similar improvements on the MAAS [21].

Stress

A comprehensive meta-analysis by Jayawardene and colleagues [22••] considered eight separate randomized controlled trials that measured the effects of digital mindfulness interventions on stress. The digital interventions were all administered online, and most were adapted from the MBSR protocol [23], although they varied in duration from two to twelve weeks. Meta-analysis of the eight studies found a significant medium effect size for the mindfulness interventions on perceived stress.

Further research utilizing a variety of d-MBIs and participant populations has provided additional support for the efficacy of d-MBIs in reducing stress [24–28]. However, failures to replicate this stress effect have occurred [29,30].

Depression & anxiety

Boettcher *et al.* [31] analyzed the effect of an eight-week d-MBI on reducing depression and anxiety among a sample of participants diagnosed with an anxiety disorder. The d-MBI decreased both depressive symptoms and anxiety. Similarly, Querstret *et al.* [32] found that a four-week d-MBI that consisted of lessons and guided meditations also reduced depressive symptoms and anxiety in a community sample. Krusche *et al.* [33] utilized the same course as Querstret *et al.* [32], and reported similar reductions in depression for those participants who completed the course. Finally, additional studies found a two-week d-MBI to significantly decrease anxiety and depression in university staff and students [18•,34].

Across these categories of outcomes, this review suggests that d-MBIs may be a promising approach for delivering mindfulness training; however, this work has limitations due to the nascence of d-MBIs. For example, a quarter of the studies described did not include a control condition. Additionally, completion rates were often quite low. Across the studies described, the average attrition rate was 34.5%. Even with participants who technically completed the intervention, 44% of the studies we reviewed mentioned problems with adherence; participants were not fully engaging in the lessons and activities as prescribed. These challenges, amongst others, are necessary to acknowledge and address as d-MBIs become increasingly commonplace.

Challenges

While d-MBIs have many potential advantages, they also face numerous challenges. A review of the literature reveals at least six categories of challenges that many d-MBIs must strive to overcome, most of which are challenges for in-person training programs as well.

Selecting an audience

No two audiences are the same. Middle school students and military veterans, for instance, have dramatically different needs, interests, and capabilities. d-MBIs must be sensitive to the distinguishing characteristics of their chosen target audience. For example, d-MBIs that include a spiritual dimension risk having users with strong religious affiliations feel that mindfulness is inconsistent with their religious beliefs [35].

Selecting objectives

A d-MBI lacking clear objectives may fail to reach its full potential impact on valued outcome measures. This is because different approaches to teaching mindfulness

may be best suited for achieving-specific outcomes. For example, Querstret *et al.* [36•] observed that although a d-MBI improved three facets of mindfulness, only one facet, Acting with Awareness, mediated the effects of the d-MBI on key outcome measures of work-related rumination, fatigue, and sleep quality. One resulting hypothesis is that a d-MBI designed at the outset to improve a specific outcome may be most effective if instructional emphasis is placed on the facets of mindfulness most likely to mediate that outcome.

Audience diversity

It is also important for d-MBIs to address individual differences within their target audience. For example, a portion of users will possess a fixed mindset about their ability to be mindful, believing that this capacity is immutable. This, in turn, can lead to decreased effort [37,38]. Individuals with a fixed mindset would therefore benefit from tailored instruction that would promote a growth mindset.

Maintaining engagement

As described briefly above, users of many d-MBIs have problematically low adherence. Several studies assessing d-MBIs report high participant drop-out, with one review paper reporting attrition rates ranging from 7.7% to 52.3% [39]. Furthermore, some participants report having difficulty staying engaged with d-MBI exercises. Instead, users sometimes end up using the meditation practices as a time to intentionally engage in ruminative thinking and to create a mental to-do list [40•].

Effective learning

Effective learning includes not only the retention of factual knowledge, but also a conceptual understanding that allows for the flexible use, transfer, and application of knowledge across contexts [41]. Achieving effective learning is a challenge in any context, and this is certainly true for d-MBIs. Participants of MBIs have reported struggling to grasp the core concepts of mindfulness, expressed uncertainty that they're practicing correctly, or misinterpreted the purpose of the intervention entirely [40•,42].

Troubleshooting

It is inevitable that individuals will encounter obstacles and frustration when training in mindfulness. Users of d-MBIs have reported experiencing negative thoughts and anxious feelings during meditations [9•,40•], as well as a desire to discuss these emerging thoughts and feelings with an instructor or peers [9•]. Other challenges that arise are discomfort, difficulty sustaining focus, feeling self-critical, and doubts that mindfulness is helpful [40•]. Leaving these challenges unaddressed leads to decreased engagement [9•,40•,43].

Best practices

Although d-MBIs face numerous challenges, these issues can be mitigated by creatively applying the best practices in digital learning.

Defining and understanding your audience

If program creators are to build optimally effective d-MBIs, they must first select and understand their audience. Defining-specific target audience demographics early on paves the way for user research. Conducting user research on target audience behaviors, needs, and motivations can inform the design and content of a d-MBI. User research methodologies can include surveys, focus groups, persona development, and individual interviews, among others [44].

Selecting learning objectives and target outcomes

After defining and understanding a target audience, program creators can make an informed decision when selecting learning objectives and training outcomes that are most relevant to their audience. For example, if the target audience has a clinical diagnosis of ADHD, learning objectives might consist of *cultivating a growth mindset about attention* and a target outcome might be *improving sustained attention*. Selected learning objectives and target outcomes can then inform the design of program content to increase the d-MBI's relevance and efficacy [45].

Addressing audience diversity

Members of a specific target audience often share certain characteristics, but heterogeneity will undoubtedly exist. Personalization of program content can facilitate individual engagement and improve learning outcomes by aligning a user's experience with their existing knowledge, interests, and goals [46,47,48•].

Maintaining engagement

Sustained engagement throughout the entirety of a d-MBI is essential. This can be achieved through personalization [12,13], chunking content into short segments [49], enhancing intrinsic motivation by designing content that is truly interesting [48•], and embedding frequent constructive learning exercises that help users engage with content [50].

Effective learning

A number of best practices exist for enhancing the effectiveness of digital instruction [49]. For example, materials should be broken into segments and reviewed regularly [51]. It is also well-established that including graphics and visuals significantly improves learning [52]. Digital instruction is also enhanced when extraneous words, graphics, and sounds are omitted [53]. Working memory capacity is limited, so presentational clutter can prevent processing of key concepts [49].

Troubleshooting

d-MBIs possess the capability to proactively address challenges that may be faced by users. Anticipating common challenges early on, identifying challenges as they arise, and offering support in an efficient and accessible manner can mitigate many issues that occur [54,55]. For example, when a challenge is identified, users can be directed to a support page that provides responses to a list of common challenges experienced. Moreover, discussion forums can connect users, providing a community of individuals who may be willing to listen, offer support, and share their own challenges. If possible, trained staff and counselors can provide emotional support when necessary [56].

Conclusion

Given the widespread use of mindfulness apps and digital courses, d-MBIs are rapidly becoming the predominant way that people around the world are introduced to mindfulness. This understandably gives some people pause, as the direct transmission of mindfulness training from instructor to student has been the norm until recently. As noted, although this distribution method is promising, there are challenges to a digital approach. The list of challenges described presently is not a complete account, and additional obstacles such as community building and embodiment are important for d-BMIs to address.

Despite these challenges, there is now evidence that the intersection of mindfulness and technology is already producing d-MBIs capable of eliciting meaningful benefits. Arguably, the rapidly unfolding digital revolution could succeed not only in improving the accessibility of mindfulness training, but also in increasing its efficacy. If the design of d-MBIs is guided by emerging literature on best practices and combined with an empirical approach of constant iteration and improvement, the highest quality mindfulness training may eventually be accessible to anyone with an internet-connected device. Then wherever you go, there it is.

Conflict of interest statement

Nothing declared.

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