

Supporting Mindfulness Based Interventions with Social Virtual Reality

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Abstract. In this work in progress report, we outline the rationale, theoretical framework, and experimental design for a study focused on leveraging virtual reality to make mindfulness-based interventions more accessible to critical populations. Mindfulness-based interventions can help individuals manage stress and mitigate professional burnout but are often difficult to access due to time constraints and other limitations. We discuss some of the advantages of using virtual and mixed reality systems to reduce logistical burdens associated with practice as well as important factors to consider when designing a system for clinical interventions.

Keywords: virtual reality, mindfulness, group sessions

1. Introduction

Mindfulness has become increasingly an increasingly popular practice in a range of organizational contexts. The U.S. and New Zealand militaries are implementing mindfulness practice as a way to help train their soldiers to be more resilient and focused during stressful situations. For veterans and other populations with PTSD, mindfulness training can help individuals avoid thought traps and better understand their emotional states, leading to reduced symptoms. Mindfulness can also help teachers and nurses cope with professional burnout while simultaneously preparing them to handle stressful interpersonal situations through more purposeful responses.

Mindfulness is paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally[1]. There are several elements to mindfulness, including breath work, body scan, yoga, and meditation with inquiry. Mindfulness practice can help with depression [2], [3], anxiety [4], PTSD [5], stress [6], chronic pain [7], as well as improve focus [8], emotional regulation [9], and empathy. Mindfulness primarily affects change through rewiring of neural circuitry. Sustained practice improves working memory and attention regulation, which can lead to heightened focus during stressful situations. In addition to attention regulation, mindfulness practice facilitates emotional regulation through top-down regulation strategies. Mindfulness practice can also train the brain to selectively shift between endogenous and exogenous thinking. Mindfulness practice results in lower activation of the default mode network [10], associated with rumination or endogenous thoughts, and more on the task positive network (TPN), which is associated with exogenous concentration directed towards demanding tasks.

Mindfulness is not a panacea; we prefer to think of it as a structured training regimen for the mind that has been honed over several millennia. The mind benefits in similar ways as the body benefits from regular exercise. Exactly how those benefits accrue and how to optimize practice still requires scientific investigation. Our long-term goals are to reduce stress and improve human performance in populations exposed to high levels of stress. To realize that goal, we focus on innovative tools to help individuals develop critical skills that allow them to proactively manage stress in a healthy, sustainable manner. Our

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tools focus on combining contemplative practices, like mindfulness-based interventions (MBI), and information and communication technologies, like virtual and mixed reality, to give members of those populations the tools they need to function with stress in a healthy manner.

Teachers makes a good candidate population for the development and testing of the ICT platform because teachers, especially novice teachers, report high levels of stress for multiple reasons; lack of student readiness, maintaining classroom discipline, time pressure, and heavy workloads all contribute to teachers' perception of occupational stress [11]. High levels of stress lead to professional burnout [12], which in turn leads to teacher attrition [13]. For example, the current attrition rate for teachers with less than five years of experience is 21% and the turnover rate for all teachers across the district is 13% [14]. High teacher turnover is common and expensive burden for school districts across the nation, especially in districts with high percentages of lower socioeconomic students.

Mindfulness-based interventions (MBI) [15] are hypothesized to give individuals, including teachers, the ability to better handle the stress of their professional and personal lives [12], [16]–[18] and have been shown to be generally effective for a wide range of psychosocial difficulties [19]. Here, mindfulness is defined as “the self-regulation of attention so that it is maintained on immediate experience... characterized by curiosity, openness, and acceptance” [20]. Research has shown that MBI can reduce stress through several mechanisms, including improving: emotional regulation [21], attentional regulation [8], [22], self-compassion [18], and coping [23], [24] . In a recent meta-study examining the link between teacher dispositions and job-related outcomes, teacher emotional stability had the largest effect size on reducing professional burnout [25]. Additionally, some studies report MBIs can lead to an increase in empathy, compassion [26], [27], perspective taking, and a tendency toward forgiveness [46], which can improve a teacher's interpersonal relationships with their colleagues and students [18].

Despite the mounting evidence that MBIs are useful for managing stress, getting individuals to engage and adhere to mindfulness practice is difficult resulting in high levels of variability in outcomes [7]. There are different barriers to adherence depending on which component of the intervention the participant is engaging with. More specifically, MBIs typically involve a combination of weekly in-person group instruction, along with daily individual practice at home. Additional (i.e., more than once per week) group practice is encouraged but rare because of logistical challenges in finding a shared time and space to practice. The group practice and instructional components of MBI are important because it gives participants an opportunity to learn from one another, as participants can provide relevant examples of how mindfulness impacts their day-to-day lives, creates social accountability for engagement with the curriculum, and allows the instructor to assess and support participants development.

We have identified three challenges associated with making mindfulness accessible [28]–[30]. First, most of the training regimens are time intensive; between actual practice time and travel to practice sites, the time commitment is prohibitive. Engaging in the social component of mindfulness practice is also difficult; individuals who were self-motivated to learn mindfulness can seek out a community to build a support system to facilitate sustained practice. Many of the people we are trying to introduce the practice to do not have the level of self-motivation (yet) to persist with the practice and access to support networks is more difficult for them because they are not actively seeking to modify their social networks. In addition to the challenges associated with access to support networks, access to qualified instruction is limited, making the scalability of the intervention problematic. Finally, there is often a lack of transparent structure, which makes it difficult for novices to understand what they are working on and why. The lack of structure may be ideal for self-directed learners or more experienced practitioners who embrace the sense of open curiosity mindfulness promotes, but it can be a detriment to individuals who are stressed and dealing with multiple competing priorities.

Of the three proposed challenges discussed in the preceding paragraph, the research outlined in this paper addressed the first two related to mitigating time investment and supporting social interaction during mindfulness instruction. More specifically, we want to know whether using immersive media, like virtual and mixed reality, can make group mindfulness practice and instructors more accessible to a wider audience.

If we can reduce the time costs associated with travel to a shared physical location and if people can join active groups any time of day, two of the barriers to practice will be reduced.

2. Theory and Framework

Our previous work outlined general concepts defining the design of the virtual reality system and environment for individual users [31], [32]. This paper reports our work in progress on further expanding the capabilities of that system to more broadly support the entire practice of mindfulness. In contrast to previous research using virtual reality to support mindfulness practice, our work focuses on virtual reality as one component of a system that delivers mindfulness as part of a clinical treatment or support program. Consequently, our conceptual framework takes into account standard frameworks about user experience in virtual reality, including presence and social presence, as well as intervention assessment concepts, including treatment acceptability, efficacy, and effectiveness.

Anytime we design a virtual environment, we are concerned about the users' experiences within that environment and whether they recognize and are focused on the fact that they are in a simulated environment or if they are focused on what the designers are trying to communicate or accomplish with the virtual reality technology. *Physical presence* is the extent to which the user feels transported to the virtual environment [33]–[35]. Presence can moderate or be moderated by features within the virtual environment. For example, inclusion of phobia inducing stimuli can enhance presence [36], while others have varied the level of presence by using technologies with different levels of immersion to test the psychological effects of fear inducing stimuli [37].

In addition to physical presence, our system is designed to address the logistical challenges of mindfulness practice; those challenges are primarily social in nature - connecting and maintaining interactions with a group and instructors. That is, facilitating interactions is time consuming, inconvenient, and sometimes improbable. Information and communication technologies (ICTs) can support synchronous social interaction with geographically distributed participants. The extent to which participants notice the mediating technology is the concern. If face-to-face interaction is the gold standard, then all technology supported communication should emulate or augment face-to-face communication. Presence (as described above), and *social presence* in particular, are concepts that help us understand whether users perceive specific instances of technology supported communication as being "real". Put another way, *social presence* helps us understand the extent to which people notice the medium when they are communicating. Do all participants feel as if they are sharing a physical space or do they feel as if they are talking through a piece through technology?

Mindfulness practice is a form of meditation; individuals engage in a series of practice sessions. Ideally, individuals would be fully engaged and have a rewarding experience each time they practiced. However, it is normal for individuals to have frustrating experiences, where they have difficulty focusing because of environmental distractions, physical discomfort or a wandering mind. From a group practice perspective, less research has been done on the quality of group sessions, but anecdotally, practitioners report a shared energy or connection that makes group practice qualitatively different.

For individual practice sessions, we hypothesize that the quality of the session is strongly correlated with their sense of presence in the virtual environment. Assuming the virtual environment is compatible [38] with the individual, the more present they feel in the virtual environment that is designed to promote tranquility, the easier it is for them to fully engage in the mindfulness session. Therefore, our first hypothesis is:

H1: Physical presence is positively correlated with meditation depth.

For group sessions, we hypothesize the quality of the session is correlated with a sense of shared connection to the other members of the group. That connection is thought to amplify and change the meditation experience. It is an open question as to whether the qualitative experience and sense of shared energy can be recreated through virtual reality. However, for that shared connection to occur, the technology must facilitate social presence. Social presence is formally defined in a mutual interaction with a perceived entity, as the degree of initial awareness, allocated attention, capacity for both content and affective

comprehension, and the capacity for both affective and behavioral interdependence with said entity [39]. Therefore, we hypothesize:

H2: Social presence is positively correlated with meditation depth in group meditation sessions.

Mindfulness-based interventions work when individuals engage in sustained practice because mindfulness is a skill. *Adherence* is the extent to which the patient or user follows medical advice [40]. Mindfulness-based interventions include the following treatment protocols: daily practice, journaling, and periodic group practice. The extent to which individuals engage in each of these three protocols will influence the effect of the intervention on the dependent variables of interest (e.g., stress and professional burnout).

Treatment acceptability has been described as the degree to which an individual perceives a treatment procedure to be fair, reasonable, appropriate and un-intrusive for a given clinical problem [40]. Are mindfulness-based interventions acceptable to the target population? Evidence from previous research suggests only a portion of the target population view the treatment as acceptable because of the barriers to practice we mentioned above. In such cases, we argue that the *feasibility*, or whether the intervention is relevant and sustainable [41], is low because the treatment is not sustainable.

Currently, our primary hypothesis is that the increased convenience of using virtual reality to participate in group meditation sessions as well as its ability to create idealized environments to participate in individual practice sessions will increase practice adherence.

H3: The ability to use virtual reality to participate in group meditation sessions will increase practice adherence.

However, we only expect adherence to increase and for individuals to evaluate the virtual group sessions as an acceptable treatment if they perceive that they are actually practicing with other people. Put another way, if the virtual environment fails to support a sufficient level of social presence, then the individuals will not consider the system to be a suitable solution to barriers to mindfulness practice.

H4: Social presence is positively correlated with treatment adherence and treatment acceptability.

Our goal for this research is to reduce teacher burnout and attrition through the use of a mindfulness intervention. In particular, we hypothesize mindfulness practice will reduce teacher stress and improve psycho-social functioning.

H5A: Mindfulness-based intervention practice reduces stress as compared to a wait list group.

Because we expect practice frequency and adherence to be greater with teachers who have access to virtual reality supported MBIs. Therefore, we hypothesize:

H5B: Teachers who have access to a virtual reality supported MBI will have higher levels of adherence than teachers who engage in analog interventions. Consequently, teachers who have access to virtual reality supported MBIs will report lower levels of stress and higher levels of psychosocial functioning.

3. Methods and Measures

3.1. Methods

Our plan is to run a one-year, between-subjects, randomized controlled trials (n=30). Each year there will be a control group (CG) that will participate in standard professional development and a treatment group that participates in the MBI. Participants will be given daily professional development time to participate in the study to overcome some of the time barriers to practice. Teachers will be able to voluntarily withdrawal from the research component (i.e., assessment) of the study, or switch from the MBI to the CG group at any time.

Table 1: Proposed timeline

What	When	Notes
(T1) Training 1	Mid-August	2-hours on mindful breathing exercises
(TM) Daily text messages	First 2 weeks	Reminders to practice plus stress measure
(T2) Training 2	End of orientation	2-hour refresher on mindful breathing exercises
(TM) Weekly text messages	2 weeks through the end of the study	
(M) Regular meetings	September through June	Regular 30-minute meetings, alternating between VR location and in-person
(T3) Training 3	~ 2 months after Training 2	Same data as the first survey, plus qualitative feedback on perceptions of training and recommendations
(F) Follow-up survey	End of the school year	Peak teacher stress period. Same data as the first survey, plus qualitative feedback on perceptions of training and recommendations

Two, 2-hour trainings will be held prior to the beginning of the school year (Training 1 and 2), and 2 months after the beginning of the school year (Training 3). During the first training session (see tables below for description of timing) (T1), participants will provide informed consent. Training will instruct teachers in basic mindfulness breathing practice, identify and problem solve barriers to establishing a personal practice, and provide teachers the opportunity to discuss how they can use mindfulness breathing practices and mindful awareness to mitigate the occupational stress they experience as novice teachers. Participants will then be given a link to complete online-versions of assessment instruments. After the initial training period, teachers will be asked to engage in daily practice as well as weekly group sessions. The virtual reality group will alternate between in-person and virtual reality sessions to ensure they can compare the experience between the two delivery mechanisms. The standard MBI group will only participate in the in-person group sessions, and the waitlist group will participate in standard professional development exercises.

For the daily practice sessions, the participants will be given access to pre-recorded mindfulness audio tracks (~5 minutes long) that they can download or stream directly from the Mind Body Lab's website (<http://mindbodylab.syr.edu/resources.html>) to serve as guided practice during the week. The track encompasses a basic mindfulness training (3-minute breathing space) [42], including the cultivation of awareness of body, thoughts, and feelings. Daily practice sessions will also be made available through the virtual reality system, if the teachers want to practice in a more controlled environment

We will collect longitudinal data from both conditions (i.e., MBI and CG), including self-reported measures of stress, mental health, self-compassion, mindfulness, and occupational burnout at T1 (pre-intervention), T3 (post-intervention), and F (follow-up). Using text messages, we can track practice compliance and changes in psychosocial functioning over time and between groups to assess the effectiveness of the intervention (TM, T2, T3, F). Qualitative data (i.e., written responses to open-ended questions and recorded focus group discussion) will also be gathered at T3 and F, and these data will help refine the MBI for subsequent studies. Data collection will also include data collected by the school district, including whether teachers continue on in the district or profession the subsequent year (i.e., occupational attrition) and sick days (a proxy of health).

3.2. Measures

Based on our literature review and hypotheses (see below), we are proposing to explore the following concepts and measures, along with data collection points in parentheses if we intend to collect longitudinal data: Demographic information (T1), psychosocial functioning via the World Health Organization Quality of Life Scale [42]; Brief Symptom Inventory [43] (T1, T2, T3), self-compassion via the Self-Compassion Scale – Short form [44] (T1, T2, T3, F), Mindfulness via the Mindfulness Attention Awareness Scale [45] (T1, T2, T3, F), Stress via the Maslach Burnout Inventory for Educators [46], physical well-being via number of sick days used (F), and practice compliance via self-reports (TM). We also plan to collect the following measures in Y2 for the VR component of the study: practice compliance via logs and self-report measures (TM), physical presence* via the iGroup Presence Questionnaire [47] (TM), social presence* via the Networked Minds Measure of Social Presence* [39] (TM), perceived restorativeness* via the perceived restorativeness scale [48](TM), meditation quality* via the Meditation Depth Index [49](TM), and treatment acceptability

via [40](T2,T3,F). Concepts and measures marked with an asterisk need to be collected periodically immediately after a VR session but not after every session.

4. Conclusions

Mindfulness-based interventions (MBIs) are an effective approach for managing stress and mitigating professional burnout [18], [23]. However, adherence to MBI plans is often low due to logistical and environmental challenges. Immersive media, including virtual and mixed reality, can mitigate those challenges provided the system is designed properly. In this report, we discuss important considerations when supporting the social component of MBIs with immersive media. In particular, we focus on the relationship between clinical measures of significance for interventions and their relationship to standard assessments of technology usability and effects. More specifically, we look at the relationships between social presence, treatment adherence and acceptability, and outcome measures including stress and professional burnout.

5. Acknowledgements

This research is supported by a Collaboration for Unprecedented Success and Excellence Grant from Syracuse University.

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