



A Pilot Study Testing the Effectiveness of a Mindfulness-Based Program for Portuguese School Children

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Abstract

Objectives Research into the effectiveness of mindfulness-based programs (MBPs) in school settings has grown substantially. However, studies in the field are still scarce, present methodological limitations, and fail to examine how children's characteristics influence MBPs' effects. The twofold aim of this study was to analyze the effectiveness of an MBP on children's attention and emotional regulation, writing performance, and school grades, and to evaluate the moderating role of baseline scores, age, gender, and socioeconomic status.

Methods Fifty-seven third graders received the MBP ($n = 28$) or a health-based program ($n = 29$), which is the active control group, for 8 weeks. In each week, both programs were composed of two 30-min sessions delivered by psychologists and three 5-min sessions delivered by teachers. Before and after the implementation of the programs, we assessed teacher-rated children's attention and emotional regulation, performance-based attention networks (alerting, orienting, and conflict monitoring), writing performance (handwriting fluency, spelling, and text quality), and school grades in Portuguese, Mathematics, and Social Studies.

Results Compared to the control group, after the program, the mindfulness group displayed higher teacher-rated attention and emotional regulation, as well as better Portuguese, Mathematics, and Social Studies grades. Emotional regulation and alerting baseline scores as well as age were found to moderate the MBP's effects.

Conclusions These findings provide preliminary evidence on the effectiveness of a MBP on children's behavior and school grades. This means that students may benefit from the integration of mindfulness practices into the educational setting as a complement to the school curriculum.

Keywords Mindfulness-based programs · Children · Emotional regulation · Attention · Writing performance · School grades

Mindfulness-based programs (MBPs) offer a type of mental training aimed to cultivate certain qualities of attention to the present moment (Kabat-Zinn, 2003). Among these attitudinal qualities, non-judging, acceptance, curiosity, openness,

and kindness have been identified as critical components of MBPs (Kabat-Zinn, 1990; Shapiro et al., 2006). There has been an increased interest in testing the effects of these kinds of programs for young populations in school settings. Preliminary evidence showed benefits of MBPs on children's personal and school-related development (e.g., Maynard et al., 2017). However, this research is still scarce and presents some methodological limitations (Dunning et al., 2019), such as lack of active control groups and failure to report treatment fidelity indicators (e.g., Felver et al., 2016). Also, little is known about the extent to which participants' characteristics (e.g., baseline scores, age, gender, socioeconomic status) impact the magnitude of MBP benefits (Galvez Tan & Alampay, 2021). Overall, the mindfulness research field seems to need more studies using rigorous

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experimental designs and exploring the specific effects and moderators of MBPs.

During the past two decades, several MBPs for school settings have emerged around the world, such as Inner Explorer (Bakosh, et al., 2016); Master Mind (Parker et al., 2014); Mindfulness Education Program (Schonert-Reichl & Lawlor, 2010); Mindful Schools (Black & Fernando, 2014); Pause, Breathe, Smile (PBS; Hynds et al., 2020); and Still Quiet Place (Saltzman & Goldin, 2008). These programs are built with the same general goal: to help participants connect with their external and internal experiences by changing, maintaining, and returning their attention to the ongoing flow of body sensations, emotions, and thoughts (Lindsay & Creswell, 2019). MBPs specifically aim to develop individuals' abilities to stay aware of and accept their present external and internal experiences, identify and deal with unpleasant emotions and thoughts, connect with prosocial dispositions (e.g., empathy and compassion), and handle difficult situations by choosing how to react (Andreu & García-Rubio, 2019). These goals are so ingrained in MBPs, that they are even recognized by young participants. As reported by Bernay et al. (2016, p. 13), child participants of an MBP perceived this program to help them to “become more aware of their thoughts and feelings ... and more adept at managing their emotions in times of stress and within interpersonal relationships”. However, MBPs vary considerably in terms of their implementation.

In school settings, MBPs usually have students as the main targets and are delivered by external facilitators and/or schoolteachers, who can also benefit from these programs as part of their training to implement them. In the classroom, MBP sessions run from 2 weeks to 9 months, including 4- to 90-min sessions, delivered daily or once a week (Semple et al., 2017). Sessions with 45 min once a week for 8 weeks seem to be the most frequent option (Filipe et al., 2021). Nevertheless, some studies found benefits of MBPs with other duration, frequency, and dosage. For example, Flook et al. (2010) found improvements in the executive control, behavioral regulation, and metacognition of children with 9 to 12 years of age, after an 8-week MBP composed of two 30-min weekly sessions, compared with a control group with silent reading. With a different organization, Bakosh et al. (2018) found benefits on the school grades of children with 6 to 11 years of age after a 10-week MBP composed of 10 min-per-day audio-guided meditations, compared with a waitlist control group. With an MBP combining a long 50-min weekly session and with short 3-min sessions three times per day, Schonert-Reichl and Lawlor (2010) found gains in optimism, self-concept, and teacher-rated social behaviors among children from 9 to 12 years of age, compared to a waitlist control group. Currently, there are no indications about the ideal implementation characteristics of

MBPs. What is known is that all programs tend to combine meditations with reflective practices (Semple et al., 2017).

Meditation is a cognitive training technique in which individuals are focused on internal (e.g., heartbeat) or external (e.g., sound) stimulus, while ignoring distracting ones (Tang et al., 2015). Among the different types of meditations (e.g., transcendental or chakra meditation), MBPs usually use mindfulness meditations that comprise three interconnected core elements (Shapiro et al., 2006): intention (i.e., knowing the reason to cultivate mindfulness), attention (i.e., observing one's internal and external experiences moment by moment), and attitude (i.e., adopting a set of attitudinal features, such as being kind and open, and accepting without judgment). The attentional focus of mindfulness meditations varies in terms of levels of activation (i.e., degree to which the meditation involves movement) and body orientation (i.e., degree to which the meditation is focused on body parts) (Matko & Sedlmeier, 2019). A recent systematic review of 29 studies implementing MBPs in 9- to-12-year-olds concluded that all programs included meditations with high activation and low/medium levels of body orientation, such as mindful observation (e.g., sitting in silence or observing thoughts and emotions) and body-centered meditations (e.g., body scan or breath nose) (Filipe et al., 2021). However, only half of these programs used meditations with high levels of activation and body orientation, such as meditations with movements, which may be particularly appropriate for young participants. It has been suggested that MBPs for children should involve meditations with some degree of activation and body orientation, explained through simplified instructions and concrete metaphors along with reflexive practices (Rempel, 2012). These latter include psychoeducation moments followed by group discussions aimed to promote the generalization of learnings.

The impact of MBPs, using mindfulness meditations and reflective practices as described above, has been examined in a wide variety of children's outcomes, typically grouped into proximal and distal outcomes (Maynard et al., 2017). Given the main goals of MBPs to promote attention and emotional self-regulation, these aspects are typically considered proximal outcomes of this kind of programs (Roeser et al., 2020). In primary school, a handful of studies using active or passive controls showed that MBPs increased self-reported attention abilities (Enoch & Dixon, 2017; Tarrasch, 2018) and decreased self-reported attentional problems (Crescentini et al., 2016). These findings have been partially supported by studies using performance-based measures, such as the Attention Network Task (ANT; Rueda et al., 2004), which assesses three core attentional subsystems (Posner & Petersen, 1990). In comparison to 9–12-year-old waitlist participants, those participating in an MBP showed improvements in the conflict monitoring subsystem (i.e., ability to resolve conflicts

among responses) as well as the orienting (i.e., ability to direct and limit attention to specific stimuli) and alerting subsystems (i.e., ability to maintain a state of vigilance to environmental stimuli), although to a lesser extent (Felver et al., 2017; Saltzman & Goldin, 2008). Similar MBP benefits have been reported for emotional functioning in research with passive or waitlist controls. Studies with children and adolescents (ages 8–14) showed that MBPs decreased emotional problems (Waldemar et al., 2016) and negative affect (Vickery & Dorjee, 2016), and improved well-being and positive affect (Carvalho et al., 2017). Despite these preliminary findings suggesting the MBPs may help children to regulate attention and emotions, a couple of caveats should be considered. First, meta-analyses concluded that those positive effects of MBPs are of small magnitude (Maynard et al., 2017). Second, randomized control trials with active control groups failed to show the usefulness of MBPs in improving behavioral and cognitive outcomes (Dunning et al., 2019).

Due to its expected impact on the proximal outcomes of attention and emotional regulation, which are key skills to succeed in school, MBPs are expected to improve the distal outcome of academic achievement (Rempel, 2012; Roeser et al., 2020). Even though a meta-analysis showed non-significant effects of MBPs on academic results for youth (Maynard et al., 2017), a handful of studies conducted in subsequent years has been published. These studies measured academic achievement through core academic-related skills (e.g., writing) or via school grades. As a key academic skill across all school subjects and grades, students' ability to produce good texts seems a reliable indicator of their academic competence (Tsingos-Lucas et al., 2017). In beginning writers, the quality of their texts is largely dependent on transcription skills, such as handwriting (i.e., ability to produce words fast) and spelling (i.e., ability to follow orthographic conventions) (Limpo & Alves, 2013). The few studies that examined MBP effects on these skills reported inconsistent findings. Compared to active controls, primary students receiving an MBP were found to show greater handwriting fluency in Cordeiro et al. (2021), but better composing quality in Magalhães et al. (2022). No study found benefits of MBPs on spelling skills (Bakosh et al., 2018; Cordeiro et al., 2021; Magalhães et al., 2022). School grades are another good indicator of academic achievement because they reflect children's knowledge and classroom behavior in a specific subject. Recent studies showed the benefits of MBPs on primary students' grades across different school subjects, such as Mathematics (Bakosh et al., 2018; Magalhães et al., 2022), Social Studies (Bakosh et al., 2018), and Literacy (Cordeiro et al., 2021). Bakosh et al. (2018) also found that mindfulness training had a widespread benefit on overall academic achievement, as indicated by improvements in the average of quarterly term grades.

In general, the impact of MBPs on primary students' proximal and distal outcomes is encouraging. Still, the amount of evidence is limited since the field is still in its infancy and the quality of the studies questionable. Moreover, few studies examined whether children's characteristics influence the direction or magnitude of MBPs' effects (Gardner et al., 2010). Examining moderators of effectiveness allows the identification of participants who are most responsive to the program and those who may require modified or alternative approaches (Kraemer et al., 2002). Relevant participants' characteristics that may moderate MBP effects are baseline scores, age, gender, and socioeconomic status.

A question still to be answered is whether participants' cognitive and emotional profile at the beginning of an MBP influences its effects. The moderating role of these scores has been barely explored. Though some studies did not confirm this moderating effect (e.g., Van der Gucht et al., 2017), others showed that baseline scores influenced children's responsiveness. However, the direction of this effect is unclear. For example, MBPs were found to work better in students with higher levels of baseline depressive symptoms (Fung et al., 2018) but also in those with higher baseline executive functioning (Cordeiro et al., 2021). Similarly, even though some studies failed to observe a moderating effect of gender and age (e.g., Gould et al., 2012; Johnson et al., 2017; Van der Gucht et al., 2017), meta-analyses reported greater MBPs' benefits in older (Dunning et al., 2019) and female students (Carsley et al., 2018). Though barely explored in the mindfulness field, there is evidence on the moderating role of socioeconomic status on the effectiveness of cognitive and socioemotional programs. Malti et al. (2012) found that economic risk factors predicted poor behavioral improvement during a school-based social competence curriculum. It is still unknown whether similar findings emerge in the implementation of MBPs.

In sum, the field seems to need rigorous experimental studies measuring proximal and distal outcomes of MBPs and likely moderators of effectiveness, as noted by several scholars (Dunning et al., 2019; Galvez Tan & Alampay, 2021). This was the goal of the present study, in which we compared an experimental group receiving an MBP with an active control group receiving a health-based program (HBP). Both programs were implemented with third graders for 8 weeks. We put forward two research questions: (1) Is MBP effective in teacher-rated attention and emotional regulation and performance-based attentional networks (proximal outcomes), as well as writing performance and school grades (distal outcomes)? (2) Does the impact of an MBP on these proximal and distal outcomes differ depending on baseline scores, age, gender, and socioeconomic status? Based on previous findings, we hypothesized that, at post-test, the MBP would surpass the HBP in attention

and emotional functioning (Rempel, 2012; Roeser et al., 2020), as well as writing performance (Cordeiro et al., 2021; Magalhães et al., 2022) and school grades (Bakosh et al., 2018; Magalhães et al., 2022). Also, we expected that the effects of the MBP in the abovementioned outcomes would be moderated by baseline scores, age, gender, and socioeconomic status (Carsley et al., 2018; Cordeiro et al., 2021; Dunning et al., 2019).

Method

Participants

This study included four grade 3 classrooms from a school in Portugal, which were allocated to the MBP or HBP groups (two classrooms per group). Because the two programs were included in the school's activity plan, all third graders participated in the programs ($N=63$). The following exclusion criteria were defined for this study: presence of special education needs ($n=3$) and no consent from the legal guardian to participate in the evaluation moments ($n=3$). Thus, the data analytic sample included 28 students in the MBP group ($M=7.80$ years, $SD=0.35$; 64% girls) and 29 students in the HBP group ($M=7.78$ years, $SD=0.34$; 55% girls). The mother's educational level, used as a proxy of the child's socioeconomic status, was as follows in the MBP/HBP groups: 7/10% finished grade 4, 21/28% completed grade 9; 25/28% finished high school; 29/24% completed college; 7/7% finished college plus postgraduate studies; and 11/3% was unknown. The two groups did not differ in terms of age $t(55)=0.85$, $p=0.40$, gender, $\chi^2(1)=0.49$, $p=0.48$, and socioeconomic status, $t(51)=-0.61$, $p=0.54$.

Procedure

Intervention Programs Both programs were delivered in classroom groups for 8 weeks, between September and December 2020, during the pandemic. Each week, the programs started with two 30-min sessions delivered on Monday and Tuesday by psychologists (total of 16 sessions), followed by three 5-min sessions delivered on Wednesday, Thursday, and Friday by the schoolteacher (total of 24 sessions). To implement these sessions, all psychologists and teachers received a classroom kit. The psychologists' kit included an instructional manual with step-by-step implementation instructions, and PowerPoint files including the core themes to present and audio/video files to play as well as classroom tools (e.g., cards, progress sheets, glitter bottle). The teachers' classroom kit included an instructional manual with step-by-step implementation instructions, PowerPoint files including audio/video files to play, and a weekly challenge, to be delivered to children every Friday.

The audio/video files to present by psychologists and teachers included audio-guided meditations in the MBP and videos with stretching activities in the HBP. All other activities were provided "in-person" supported by PowerPoint presentations.

Mindfulness-Based Program This is a comprehensive classroom program based on published evidenced-based MBPs (e.g., Bakosh et al., 2018), and a previous program validated by authors (citation omitted). It aimed to enhance students' awareness and acceptance of themselves, others, and the environment through meditation and reflective practices. Each component of this program builds on skills learned and practiced in the preceding one. The program was organized into six modules. Module I—*Introduction*—presented students with the program structure and the concept of mindfulness, asking them to focus attention on the present moment with an acceptance attitude. Module II—*5 Senses*—introduced students to the practice of mindful sensing by asking them to focus attention on one or more of their senses (e.g., mindful seeing and/or listening). Module III—*Body*—taught students how to be aware and accept body sensations. Module IV—*Heart*—introduced students to the practice of observing and identifying emotions, including reflecting and dealing with unpleasant emotions. Module V—*Brain*—promoted students' abilities to observe and identify useful and useless thoughts. Lastly, Module VI—*Consolidation*—presented students with loving-kindness practices and an overview of all learned practices. Except for the first and last session, all 30-min sessions had the same structure, with these sequential moments: audio-guided breathing meditation, revision of previous learned practices, two or three audio-guided meditation or briefing activities related to the session's topic, reflection about the learned practices, and conclusion. The 5-min sessions included audio-guided meditation practices to redirect children's attention to breathing, body sensations, emotions, and/or thoughts, with purposeful and acceptance attitudes. In the Friday 5-min session, teachers also presented a weekend challenge to generalize the learned practices, whose completion was registered.

Health-Based Program The development of this program was based on the recommendations from the National Program for the Promotion of Healthy Eating (Direção-Geral da Saúde, 2012). It aimed to enhance students' knowledge about the meaning of being healthy and how to accomplish it. This program was organized into three modules. Module I—*Introduction*—presented students with the program structure and the concept of being healthy. Module II—*Inside and Outside the Food Pyramid*—taught students how to make healthy choices when eating. Lastly, Module III—*Consolidation*—presented students with an overview of all learned practices and the opportunity to develop their own

healthy plan to eat and exercise. Except for the first and last session, all 30-min sessions had the same structure, with these sequential moments: video-presented stretching activity, revising the learned practices, main activity related to the session's topic, reflection about learned practices, and conclusion. The 5-min sessions included stretching activities in video, led by Physical Education teachers. In the Friday session, teachers also presented a weekend challenge.

Fidelity of the Implementation To assure that both programs were implemented as planned, we provided all psychologists and teachers with intensive training (24 h; co-led by the first and last authors, with certified training, extensive teaching experience, and personal practice in mindfulness). This training had two main goals: to introduce the theoretical and empirical bases of the programs in a pre-program workshop (9 h); and to discuss the lessons implemented and prepare the next ones in a weekly monitoring session (90 min per session). During this intensive training, psychologists and teachers were provided with several activities to ensure personal daily mindfulness practice. Moreover, we provided psychologists and teachers with checklists to indicate lessons' step completion. All lesson steps were completed in both groups, except one 5-min session in all classrooms because of the pandemic. Also, during the implementation, some classrooms were sent home by the Portuguese Directorate-General of Health due to COVID-related situations. Four sessions in the two MBP groups and six sessions in one HBP group were conducted online, without compromising the fidelity of the implementation. In addition, independent observers filled in 30% of the lesson checklists. Results showed a complete agreement between psychologists/teachers and independent observers in both programs.

Evaluation Moments Proximal and distal outcomes were assessed in the week before (baseline) and after (posttest) the program implementation. Students' attention and emotional regulation behaviors were assessed by the respective school-teacher, who was asked to respond to an online questionnaire. To collect performance-based attention and writing measures, they were asked to participate in one 20-min individual session and another 20-min classroom group session. In the individual session, students were asked to perform the ANT. This task was administered in a quiet room by a trained research assistant, who provided detailed instructions to children. They were asked to feed a fish (target stimulus) centrally presented on the computer screen as fast and accurately as possible. In the classroom group session, students were asked to perform three tasks: sentence copying, spelling through dictation, and opinion essay writing. Moreover,

teachers provided students school grades in Portuguese, Mathematics, and Social Studies.

Measures

Teacher-Rated Attention and Emotional Regulation To measure students' attention, we administered the 9-item inattention subscale of the Vanderbilt Attention-Deficit Hyperactivity Disorder Diagnostic Teacher Rating Scale (Wolraich et al., 1998; Portuguese version: Oliveira et al., 2019, $\alpha=0.84$). Teachers are asked to indicate how often they detected a given behavior in children (e.g., difficulties in sustaining attention or in organizing tasks/activities), in a 4-point scale from 1 = *never* to 4 = *very often*. Rather than using the recommended dichotomic coding, we averaged teachers' responses to obtain a continuous score. To facilitate interpretation, answers were reverse coded; thus, higher values indicate larger attention skills. In this sample, Cronbach's alpha was 0.93 at pretest and post-test. To measure students' emotional regulation, we used the 15-item lability and negativity subscale of the Emotions Regulation Checklist (Shields & Cicchetti, 1997; $\alpha=0.90$; Portuguese version: Alves & Cruz, 2011). Items are rated on a 4-point scale (from 1 = *never* to 4 = *almost always*) measuring the occurrence of a set of behaviors (e.g., impulsivity or mood swings). As before, we reversed the answers, so higher values indicate larger emotional regulation skills. Cronbach's alpha was 0.76/0.80 at pretest/posttest.

Performance-Based Attentional Networks We used the children's version of the ANT (Rueda et al., 2004). This task assesses three core attentional networks subsystems (Posner & Petersen, 1990), namely, alerting, orienting, and conflict monitoring. The ANT includes 24 practice trials, followed by three blocks of 48 test trials representing one out of 12 conditions: 3 Flankers (neutral, congruent, and incongruent) \times 4 Cues (none, central, double, and orient). Mean reaction time (RT) in milliseconds and mean accuracy were extracted for each condition, using an Excel macro (Fan et al., 2001) following the guidelines of Conners et al. (2000). To quantify each network, we compared mean RT between no cue and double cue conditions (alerting), central cue and orient cue conditions (orienting), and congruent and incongruent flanker conditions (conflict monitoring). Lower scores in alerting and orienting indicate faster cue-related performance; higher scores in conflict monitoring indicate worst performance.

Writing Performance We collected three measures: handwriting fluency, spelling, and composing quality. For handwriting fluency, we used the sentence-copying task (Limpo

& Alves, 2013), which evaluates the number of words correctly copied in 90 s. Higher scores indicate greater fluency. For spelling, we used the 16-word Portuguese dictation task (Magalhães et al., 2020), which evaluates the number of spelling errors. Higher scores indicate poorer spelling ability. For the abovementioned tasks, 30% of the written materials at pretest and post-test were re-scored by a second judge. Inter-rater reliability, measured with the intra-class correlation coefficient for single measures, was above 0.98. For composing quality, we asked two trained judges to evaluate all opinion essays using a holistic scale considering creativity, coherence, syntax, and vocabulary (from 1 = *low quality* to 7 = *high quality*; see Limpo & Alves, 2013). All texts were typed and corrected for spelling and punctuation errors, which is a standard procedure to avoid biased judgments (Graham et al., 2011). Also, all pretest and post-test texts from both groups were randomized and grouped into a single, anonymized pool of texts. The intra-class correlation coefficient for average measures was above 0.96. Thus, for each text, the scores were the average across two judges. Higher scores indicate better text quality.

School Grades We collected students' grades in Portuguese, Mathematics, and Social Studies. Grades were assigned by teachers at the end of each term on a scale ranging from 1 (*insufficient*) to 4 (*very good*). For the present study, we collected the most recent grades before the start of programs and, again, after the end of the implementation.

Data Analyses

All data were examined using the SPSS (version 27.0). Before the main tests, we performed three preliminary steps. First, we examined the pattern of missing data with the Little's Missing Completely at Random test. Results showed that data were missing completely at random, $\chi^2(773) = 317.96$, $p = 1.00$, indicating the appropriateness of using a pairwise deletion technique to deal with missing data (Garson, 2015). Given the small sample size, this technique was used to minimize data loss, by deleting cases with missing values only in the variables under analysis. Second, we calculated descriptive statistics to examine sample's characteristics and the adequacy of using parametric procedures. Absence of severe deviations from the normal distribution was considered if skewness $< |3|$ and kurtosis $< |10|$ (Kline, 2016). Third, as interventions occurred in intact classroom groups, we checked if there was evidence of nested effects. For that, we conducted linear mixed modeling introducing condition and classroom as fixed and random effects, respectively. As the random classroom effect never reached statistical significance, for parsimonious reasons, it was not considered in the main analyses.

Comparison Between MBP and HBP To test baseline differences between MBP and HBP for each set of dependent variables (teacher-rated attention and emotional regulation, performance-based attention networks, writing performance, and school grades), we conducted multivariate analyses of variance (MANOVAs). Then, to test differences between MBP and HBP on the same set of dependent variables at posttest, we performed multivariate analyses of co-variance (MANCOVAs), controlling for baseline scores of the dependent variables under analysis. Statistically significant effects ($\alpha = 0.05$) were followed up with univariate analysis of covariance (ANCOVAs) for each dependent variable, with group as the between-subjects factor (MBP vs. HBP) and controlling for the same baseline scores entered in the MANOVA. Partial η^2 was used to estimate effect sizes (small = 0.01, medium = 0.06, and large = 0.14; Cohen, 1988).

Moderation Effects To examine the moderating role of baseline scores, we replicated the analyses above, but added the Baseline Scores \times Condition interaction term. To test the moderating role of age, gender, and socioeconomic status, we conducted a set of three MANCOVAs, in which we included condition, baseline scores, and the moderator along with the respective interactions with condition. Significant effects ($\alpha = 0.05$) were examined through univariate tests. Significant interactions, which provided evidence of moderation, were decomposed using the PROCESS macro (version 3.5; Hayes, 2018).

Results

An inspection of the skewness and kurtosis of all baseline and posttest variables by group indicated no severe distributional problems, as these values were below $|1.93|$ and $|4.87|$, respectively (Kline, 2016). Complete descriptive statistics are presented in Table 1.

Comparison Between MBP and HBP—Proximal Outcomes

Concerning teacher-rated attention and emotional regulation, a preliminary MANOVA on baseline scores showed no differences between groups, Wilks' $\Lambda = 0.95$, $F(2, 54) = 1.44$, $p = 0.25$; $\eta_p^2 = 0.05$. The MANCOVA examining group differences on teacher-rated children's behavior at posttest controlling for baseline scores revealed a main effect of baseline attention, Wilks' $\Lambda = 0.35$, $F(2, 55) = 49.39$, $p < 0.001$, $\eta_p^2 = 0.66$, and baseline emotional regulation, Wilks' $\Lambda = 0.84$, $F(2, 55) = 5.06$, $p = 0.01$, $\eta_p^2 = 0.16$. Moreover, there was a significant condition effect, Wilks' $\Lambda = 0.79$, $F(2, 55) = 7.01$,

Table 1 Descriptive statistics for all dependent variables by condition and testing time

Measures	Mindfulness group						Health group							
	Pretest			Posttest			Pretest			Posttest				
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>M_{adj}</i>	<i>SE</i>
Proximal Outcomes														
Teacher-rated Attention	28	3.24	0.43	28	3.54	0.41	29	2.98	0.69	29	3.07	0.67	3.17	0.06
Emotional regulation	28	3.47	0.26	28	3.68	0.29	29	3.37	0.32	29	3.44	0.24	3.47	0.04
Performance-based attentional networks														
Orienting	27	37.03	67.67	28	44.13	41.55	29	51.77	64.07	27	49.08	47.15	49.33	8.63
Alerting	27	80.28	68.21	28	109.49	59.42	29	97.12	58.64	27	111.26	52.04	110.31	11.17
Conflict	27	99.35	62.82	28	70.82	57.68	29	99.14	51.73	27	60.11	41.17	59.93	9.05
Distal Outcomes														
Writing performance														
Handwriting fluency	26	15.04	2.89	27	18.41	3.49	29	18.31	7.02	28	20.54	5.06	19.53	0.61
Spelling errors	26	11.38	2.52	27	10.33	2.67	29	10.14	2.39	28	9.00	2.68	9.49	0.33
Composing quality	26	3.31	1.16	27	3.89	0.98	29	3.57	1.25	28	4.64	1.54	4.47	0.20
School grades														
Portuguese	27	2.85	0.82	28	2.61	0.88	29	3.10	0.62	29	2.69	0.71	2.51	0.08
Mathematics	27	2.81	0.79	28	2.82	1.06	29	3.24	0.74	29	2.83	0.80	2.60	0.11
Social Studies	27	2.96	0.76	28	3.04	0.88	29	3.48	0.57	29	3.21	0.77	3.01	0.09

M_{adj} = Posttest mean of each group adjusted by controlling for the pretest scores

Table 2 Estimates of the condition effects on teacher-rated attention and emotional regulation controlling for baseline scores

Predictors	$F(1, 56)$	p	η_p^2
Posttest attention			
Baseline attention	100.16	< .001	.65
Baseline emotional regulation	5.97	.02	.10
Condition	10.35	.002	.16
Posttest emotional regulation			
Baseline attention	2.25	.14	.04
Baseline emotional regulation	4.96	.03	.09
Condition	8.36	.01	.14

$p=0.002$, $\eta_p^2=0.21$. In the follow-up ANCOVAs (Table 2), we found that baseline attention was related to posttest attention ($p < 0.001$), and that attention and emotional regulation at baseline were related to posttest emotional regulation ($p=0.02$ and $p=0.03$, respectively). Additionally, at posttest, the MBP group received higher attention and emotional regulation scores than the HBP group ($p=0.002$ and $p=0.01$, respectively).

For performance-based attentional networks, a preliminary MANOVA on baseline scores revealed no group differences, Wilks' $\Lambda=0.97$, $F(3, 52)=0.57$, $p=0.64$, $\eta_p^2=0.03$. The subsequent MANCOVA also showed no effects of baseline scores or condition on post-test scores, Wilks' $\Lambda < 0.93$, $F(3, 47) < 1.21$, $p > 0.32$, $\eta_p^2 < 0.07$. ANCOVAs were thus not performed.

Comparison Between MBP and HBP—Distal Outcomes

Concerning writing performance, a preliminary MANOVA on baseline scores showed no differences between groups, Wilks' $\Lambda=0.86$, $F(3, 51)=2.67$, $p=0.06$, $\eta_p^2=0.14$. The MANCOVA examining group differences on writing performance at post-test with the respective baseline scores as covariates revealed a main effect of baseline handwriting fluency, Wilks' $\Lambda=0.53$, $F(3, 47)=14.03$, $p < 0.001$, $\eta_p^2=0.47$; baseline spelling accuracy, Wilks' $\Lambda=0.56$, $F(3, 47)=12.41$, $p < 0.001$, $\eta_p^2=0.44$; and baseline composing quality, Wilks' $\Lambda=0.80$, $F(3, 47)=3.84$, $p=0.02$, $\eta_p^2=0.20$. In the follow-up univariate analyses (Table 3), we found an association between baseline and post-test scores in handwriting fluency ($p < 0.001$), spelling accuracy ($p=0.001$), and composing quality ($p=0.002$). However, there were no condition effects on writing performance at posttest, Wilks' $\Lambda=0.96$, $F(3, 47)=0.75$, $p=0.53$, $\eta_p^2=0.05$.

Regarding school grades, a preliminary MANOVA on baseline scores indicated that school grades at pretest differed between groups, Wilks' $\Lambda=0.83$; $F(3, 52)=3.53$, $p=0.02$, $\eta_p^2=0.17$. Before the intervention, the HBP group

Table 3 Estimates of the condition effects on writing performance controlling for baseline scores

Predictors	$F(1, 53)$	p	η_p^2
Posttest handwriting fluency			
Baseline handwriting fluency	43.34	< .001	.47
Baseline spelling accuracy	0.02	.90	< .001
Baseline composing quality	1.25	.27	.03
Condition	< .001	.90	< .001
Posttest spelling accuracy			
Baseline handwriting fluency	0.51	.48	.01
Baseline spelling accuracy	37.55	< .001	.43
Baseline composing quality	2.66	.11	.05
Condition	0.47	.50	.01
Posttest composing quality			
Baseline handwriting fluency	2.68	.11	.05
Baseline spelling accuracy	1.28	.26	.03
Baseline composing quality	10.48	.002	.18
Condition	1.90	.18	.23

had better grades in Mathematics ($p=0.04$) and Social Studies ($p=0.01$) than the MBP group. The MANCOVA examining group differences on school grades at post-test controlling for baseline scores revealed a main effect of baseline grades in Portuguese, Wilks' $\Lambda=0.71$, $F(3, 49)=6.55$, $p < 0.001$, $\eta_p^2=0.29$, and Social Studies, Wilks' $\Lambda=0.74$, $F(3, 49)=5.88$, $p=0.002$, $\eta_p^2=0.27$. ANCOVAs (Table 4) showed that pretest grades in Portuguese and Social Studies were related to post-test grades in Portuguese, Mathematics, and Social Studies (all $ps < 0.02$). Additionally, we found an effect of condition on posttest grades, Wilks' $\Lambda=0.82$, $F(3, 49)=3.62$, $p=0.02$, $\eta_p^2=0.18$, showing that MBP students

Table 4 Estimates of the condition effects on school grades controlling for baseline scores

Predictors	$F(1,55)$	p	η_p^2
Posttest Portuguese grades			
Baseline Portuguese grades	17.69	< .001	.26
Baseline Mathematics grades	6.40	.06	.11
Baseline Social Studies grades	5.94	.02	.10
Condition	6.77	.01	.12
Posttest Mathematics grades			
Baseline Portuguese grades	0.90	.35	.01
Baseline Mathematics grades	< .001	.98	< .001
Baseline Social Studies grades	0.35	.56	.01
Condition	7.24	.01	.12
Posttest Social Studies grades			
Baseline Portuguese grades	12.23	< .001	.19
Baseline Mathematics grades	9.05	.004	.15
Baseline Social Studies grades	8.06	.01	.14
Condition	3.93	.05	.07

achieved better Portuguese, Mathematics, and Social Studies grades than HBP students (all $ps \leq 0.05$).

Moderation Effects

The MANCOVAs revealed two significant interactions involving condition and baseline scores, namely, emotional regulation, Wilks' $\Lambda = 0.84$, $F(2, 50) = 4.79$, $p = 0.01$, $\eta_p^2 = 0.16$, and alerting network, Wilks' $\Lambda = 0.84$, $F(3, 44) = 2.82$, $p = 0.05$, $\eta_p^2 = 0.16$. Condition effects on post-test attention were moderated by baseline emotional regulation scores ($p = 0.003$). Moderation analyses suggested that for children with baseline emotional regulation scores equal to or above 2.23 (63% of the sample), the MBP resulted in higher attention scores than the HBP (effect = 0.17, $t = 2.01$, $p = 0.05$). Moreover, condition effects on post-test alerting network were moderated by the respective baseline score ($p = 0.01$). Moderation analyses showed that (a) for children with baseline alerting scores equal or below to 25.45 (19% of the sample), the MBP resulted in lower alerting scores than the HBP (effect = -42.94 , $t = -2.01$, $p = 0.05$), and (b) for children with higher alerting scores at baseline (≥ 147.72 ; 18% of the sample), the MBP resulted in higher alerting scores than the HBP (effect = 41.08, $t = 2.01$, $p = 0.05$). It is worth reminding that lower alerting scores mean better attentional skills.

Concerning age, there was an interaction with condition on teacher-rated measures, Wilks' $\Lambda = 0.79$, $F(2, 50) = 6.55$, $p = 0.003$, $\eta_p^2 = 0.21$. Univariate analyses revealed that condition effects on posttest emotional regulation were moderated by age ($p < 0.001$). Moderation analyses suggested that for children with 8.42 years or less (57% of the sample), the MBP resulted in higher emotional regulation scores at post-test than the HBP, effect = 0.11, $t = 2.01$, $p = 0.05$.

There was no main effects or interactions for gender and socioeconomic status.

Discussion

The primary goal of this pilot study was to explore the effects of an 8-week MBP on proximal and distal outcomes in a sample of third graders. A secondary goal was to evaluate the potential moderators of MBP effectiveness. To fully achieve these goals, we conducted a preliminary step aimed to investigate the fidelity of implementation. Except one 5-min session, which was not implemented in any classroom due to the pandemic, we found that all psychologists and teachers involved in the study implemented the programs' lessons as planned. In line with the recommendations of Durlak and DuPre (2008), we therefore confirmed that the MBP and HBP were implemented with high fidelity, thereby

increasing our confidence in the interpretation of the findings. Overall, the results indicated that, compared to students in the health program, those in the mindfulness program displayed higher teacher-rated attention and emotional regulation as well as better school grades. Also, some of the effects of the MBP were moderated by baseline scores and age.

This study showed that after the programs, MBP students were rated by their teachers as having higher attention skills than HBP students. These results are in accordance with previous studies (Crescentini et al., 2016; Enoch & Dixon, 2017; Felver et al., 2017; Tarrasch, 2018) and confirm the central role of attention in MBPs (Roeser et al., 2020). This effect might be related to the meditation practices included in the program, in which students were asked to keep their attention to the ongoing flow of internal and external experiences (Lindsay & Creswell, 2019). This effect was, however, moderated by students' emotional regulation at baseline: the MBP only resulted in better attention than the HBP among students with higher emotional regulation skills before the intervention. To the best of our knowledge, this is the first study showing that a certain degree of emotional abilities is needed for mindfulness training to work. Yet, a past study, also with Portuguese third graders, already showed that an 8-week MBP was more effective among those with higher cognitive abilities at baseline (Cordeiro et al., 2021). Similar effects with older students were reported by Fung et al. (2018). Together, these studies hint at the possibility that some MBPs may be more appropriate for children with a higher cognitive and/or emotional baseline status. Nevertheless, given the few studies examining moderators of MBP effectiveness, further research is needed to support this claim (Galvez Tan & Alampay, 2021).

Our study also revealed another relevant finding concerning mindfulness training effects on attention. Despite impacting teacher-rated attention, our MBP did not affect performance-based measures of attention in the whole sample. These results contradict prior studies showing MBP benefits in the three attentional networks (Felver et al., 2017; Saltzman & Goldin, 2008). This discrepancy may be due to the amount of mindfulness practice. It has been suggested that higher practice time was associated with better attentional performance (e.g., Dunning et al., 2019). Likely, the amount of mindfulness practice provided by our MBP was enough to improve observable attentional-related behaviors, but not fine-grained attentional networks. There was however an interesting moderating effect regarding the alerting network. On the one hand, among students with lower alerting scores at baseline (i.e., faster cue-related performance), those in the MBP showed better posttest alerting skills than those in the HBP. On the other hand, among students with higher alerting scores at baseline (i.e., slower cue-related performance), those in the HBP showed better post-test alerting skills than their peers in the MBP. Although the

benefits of mindfulness training on the alerting network have already been reported (Saltzman & Goldin, 2008), the lack of moderation analyses impedes us to say if this effect occurred in the whole sample, or among those with better attentional skills, as shown in this study. Notably, this finding is congruent with the above discussion about some MBPs being more suitable for children with better cognitive and/or emotional abilities (cf. Cordeiro et al., 2021; Fung et al., 2018). The apparent beneficial effect of HBP among students with lower alerting skills at baseline is also aligned with the findings of Cordeiro et al. (2021), suggesting that concrete programs with practical activities and reduced cognitive demands may be more beneficial for students with less attentional skills. Whereas the program in Cordeiro et al. (2021) only included relaxation activities, the program tested in this study included stretching activities that may have played a similar role. Clearly, future studies should explore which training programs work best for whom.

Besides attention, our MBP also impacted emotional regulation, which also has a central role in this kind of programs (Roeser et al., 2020). This effect can be explained by the combination of meditation and reflective practices. In meditations practices, students train their abilities to observe, monitor, and accept the content of their emotional experiences. In reflective practices, they learn how to apply these abilities in their daily routine to deal with difficult situations. Together, these practices may help students to engage in adaptive processes of emotional processing, while reducing tendencies of rumination, emotion suppression, and overreaction (Crescentini et al., 2016). However, it should be noted that, as shown by our moderation analyses, these emotion-related benefits were only observed among the youngest participants (less than 8.42 years). This result reflects the mixed findings in the field. It contrasts with past studies that found stronger MBP effects in older children (Galvez Tan & Alampay, 2021) or did not find the moderating role of age (Gould et al., 2012; Van der Gucht et al., 2017). Conversely, our result agrees with a meta-analysis reporting that younger students have less emotion-related negative behaviors (e.g., aggression, hostility) than older ones (Dunning et al., 2019). In the present study, the emotional regulation benefits observed among the youngest may be linked to the large number of body-centered meditations that children practiced to deal with difficult emotions (e.g., breathing and movement meditations). On the one hand, the use of these meditations has been shown to be particularly effective in young children, including preschoolers (e.g., Berti & Cigala, 2020). On the other hand, Galvez Tan and Alampay (2021) found that a MBP lacking such meditations failed to promote emotional regulation among the youngest.

Due to its expected impact on the proximal outcomes of attention and emotional regulation, we anticipated that our MBP would impact academic-related distal outcomes

(Rempel, 2012; Roeser et al., 2020). These hypotheses were partially confirmed. Despite impacting school grades, our program did not affect writing performance. The lack of effects on spelling agrees with past research (Bakosh et al., 2018; Cordeiro et al., 2021; Magalhães et al., 2022), suggesting that, given the complex nature of spelling, promoting this skill may require explicit instruction (Graham, 2000). However, the lack of effects on the other writing measures contrasts with Cordeiro et al. (2021), who found a MBP to increase third graders' handwriting, and Magalhães et al. (2022), who found a MBP to increase fourth graders' composing quality. To the best of our knowledge, these are the only studies examining MBP effects on performance-based measures of writing, making it difficult to interpret the contrasting findings. Though they can be explained by contextual (e.g., characteristics of the MBP) and individual (e.g., age, baseline status) differences, more research is needed to unravel the mindfulness-writing link.

In line with our hypotheses and prior research (Bakosh et al., 2018; Cordeiro et al., 2021; Magalhães et al., 2022), after the intervention, students in the MBP showed higher grades in Portuguese, Mathematics, and Social Studies than those in the HBP. Two reasons may explain these positive effects. First, mindfulness training may have benefited students' grades by diminishing mind-wandering and helping them to focus during learning and assessment tasks (Caballero et al., 2019). Indeed, during the MBP, students were encouraged to use several meditation practices to increase concentration and control negative thoughts and feelings in challenging moments (e.g., school tests). Second, because primary school grades are based not only on performance in subject-specific tasks but also on classroom behavior (e.g., reaction to difficult situations, interaction with others, task management; Bakosh et al., 2018), it is possible that our mindfulness training may have positively impacted school grades by also reducing children's classroom behavioral problems (Bakosh et al., 2018). Though reasonable, these explanations should be tested in future studies, for example, by examining the variables that may mediate the link between MBPs and school grades, such as attentional control, rumination, or classroom behavior.

Finally, it should be noted that, except for the moderating effects reported above, we found no other evidence that participants' characteristics influenced MBP effectiveness. This pattern of results is encouraging because it suggests that the majority of MBP benefits seem to be observed among all students regardless of individual characteristics. This finding was particularly evident concerning school grades, which were positively impacted by mindfulness training irrespective of participants' baseline grades, gender, age, and socioeconomic status. These positive results may prompt educators to integrate mindfulness-based approaches within large classrooms with a great diversity of students. This can

be easily done through the use of pre-recorded audio-guided meditations, whose effectiveness has already been proved (Bakosh et al., 2018). Despite this easy implementation, it is however important that teachers have the proper knowledge and skills to do it. It is advisable for them to have close contact with mindfulness activities before implementing the meditations. The literature recognizes the importance of personal practice as one of the bases for developing effective MBP instructors (Kabat-Zinn, 2003). Additionally, teachers may also need to receive specific training in a validated MBP to further assure the suitability and effectiveness of their mindfulness-related work in the classroom.

Limitations and Future Research

Although the present study holds promising results, at least five limitations are worthy of attention. First, this pilot study included a reduced number of participants. Despite the practical relevance of our findings, we cannot discard the possibility that some small effects did not reach statistical significance due to the small sample. Larger, replication studies should therefore be conducted. Second, the implementation of this study occurred during the COVID-19 pandemic. Though providing evidence that the MBP may help to promote cognitive, emotional, and academic-related skills in this challenging context, it raises questions about the degree to which the program would work outside this crisis. Moreover, because a few classrooms were sent home due to COVID-related situations, some sessions of the program were administered online. However, as noted before, no issues were identified in these sessions, which occurred with the same degree of treatment fidelity as the face-to-face ones. Replication studies are needed to check if the MBP tested in this study has the same benefits outside a pandemic context. Third, as a result of a new lockdown imposed by the Portuguese government during the pandemic, we were not able to conduct a follow-up assessment. Previous evidence already showed long-term effects of MBPs. For example, an active-control study implementing an 8-week MBP with 10-year-olds showed the maintenance of mindfulness-related benefits 12 weeks after the intervention (Devcich et al., 2017). In the future, it would be useful to understand if and for how long would the benefits of our MBP be sustained. Fourth, although the measurement of attention combined teacher and performance-based indicators, that of emotional regulation did not. For a broader analyses of MBP effects, future studies should measure both proximal and distal outcomes by combining teacher, student, and parent reports with performance-based measures. Fifth, this pilot study did not examine the role of cultural factors on reported findings.

Prior reviews noted the importance of developing MBPs including adaptations that situate the program in instructors and participants' contexts as a means to optimize their positive effects (Chu & Leino, 2017; Proulx et al., 2018). Take example from the Pause, Breathe, Smile program, which was adapted to be "authentically place-based and culturally sustaining" with great success among culturally diverse New Zealand children (Hynds et al., 2020). Thus, future investigations into the moderating role of participants' cultural background may be needed to maximize the benefits of MBPs.

Despite these limitations, our findings join to a growing body of research (e.g., Bakosh et al., 2018; Cordeiro et al., 2021; Crescentini et al., 2016; Magalhães et al., 2022) suggesting that MBP may be an effective tool to promote students' socioemotional/cognitive skills and academic success. As shown in this study, these benefits can be achieved through brief 8-week MBPs, which teachers can easily put into practice during class time with minimal disruption of class activities and reduced levels of prior training.

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Author Contribution SM designed and executed the study, co-developed the interventions, analyzed the data, and wrote the first draft of the paper. TN and IS collaborated on the execution of the study. RR, AC, and MP collaborated on the study design and developed audio materials. SLC and TLe advised on the study design and revised the manuscript. TLi designed the study, co-developed the interventions, supervised the study's execution and data analyses, and assisted in data interpretation as well as in the writing of the paper. All authors commented on previous versions of the manuscript and approved its final version.

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Data Availability All data are available at the Open Science Framework (<https://osf.io/3k765>).

Declarations

Ethics Statement The study complied with the Declaration of Helsinki and was approved by the Ethics Committee of the Faculty of Psychology and Education Sciences, University of Porto.

Informed Consent Students' legal guardians gave written informed consent to include their children in the study, who also gave oral assent to participate.

Conflict of Interest The authors declare no competing interests.

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