Mindfulness (2019) 10:312–324
https://doi.org/10.1007/s12671-018-0976-2

ORIGINAL PAPER

Applying Behavioral Theory to Increase Mindfulness Practice Among Adolescents: an Exploratory Intervention Study Using a Within-Trial RCT Design

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Published online: 9 July 2018

Abstract

For mindfulness programs to have sustained benefits, participants should continue to practice mindfulness independently. Behavioral theories have been used to predict and change other health behaviors, but have rarely been applied to mindfulness practice. This research aimed to identify predictors/determinants of sustained mindfulness practice after a school-based mindfulness program (Study 1) and to develop and test a booster intervention to increase mindfulness practice (Study 2). These studies were embedded in a larger trial evaluating a school-based mindfulness program involving 12–15 year-olds (Healthy Learning Mind, HLM). Study 1 examined theory-based predictors of mindfulness practice among participants in Batch 1 of the HLM trial ($n = 310$). These findings were used to develop a brief motivational booster intervention, which Study 2 evaluated in a within-trial cluster-randomized controlled trial in Batch 3 of the HLM trial (HLM Only arm $n = 177$; HLM + booster arm $n = 152$). In Study 1, 40% of youths reported having practiced mindfulness at a 6-month follow-up. The perception that peers were practicing mindfulness exercises predicted mindfulness practice ($\beta = .497$, $p = .002$), and a key self-reported reason for non-practice was that they did not find mindfulness useful. The booster intervention (designed to specifically target these descriptive norms and outcome expectations) demonstrated some positive trends in the determinants of mindfulness practice, but did not increase mindfulness practice. The limited effectiveness of the booster intervention might be explained by the minimal contact time of the booster intervention or its delivery in the later lessons of HLM. This study demonstrates how behavior change theories can be applied to help promote independent mindfulness practice outside of intervention settings.

Keywords Determinants of mindfulness practice · Health behavior change · Behavioral theory · Theory of planned behavior · Reasoned action approach · School-based program

Introduction

Mindfulness programs have been developed and implemented in many different settings in recent years. Some mindfulness programs have been developed especially for youth, including several in school settings (Broderick and Metz 2009; Flook et al. 2010; Kuyken et al. 2013). Schools are a potentially valuable environment for teaching mindfulness exercises, as they are far-reaching and can encourage beneficial habits for young people. A recent meta-analysis concluded that school-based mindfulness training improves cognitive variables, such as attention and learning, as well as psychological measures of stress, coping, and resilience (Zenner et al. 2014).

While these programs seem to benefit young people, it is not clear whether in-class sessions alone are sufficient for students to obtain the full benefits of mindfulness practice.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s12671-018-0976-2) contains supplementary material, which is available to authorized users.

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Among adults, more frequent home practice of mindfulness exercises is associated with improvements in mindfulness and well-being and decreases in psychological symptoms (Carmody and Baer 2008). Similar evidence exists among students and adolescent populations as well. For example, Kuyken et al. (2013) found that greater practice of mindfulness after a 9-week school-based mindfulness intervention was associated with better well-being and less stress 3 months later, and Huppert and Johnson (2010) observed positive associations between the time spent practicing mindfulness outside the classroom, improvement in psychological well-being, and the quality of mindfulness reported among adolescent boys. As regular mindfulness practice seems key to improving psychological functioning and well-being, facilitating sustained mindfulness practice may be a way to improve the effectiveness of mindfulness programs.

There is little empirical evidence concerning which factors predict sustained mindfulness practice or how to best promote independent practice of mindfulness. There is the Liverpool Mindfulness Model, which hypothesizes that motivation, intention, positive expectations, and attitudes lead to mindfulness practice (Malinowski 2013). Other hypothesized predictors of mindfulness practice include certain open, "mindful" characteristics and positive attitudes towards mindfulness practice (Stanley et al. 2011), habits and self-control (Galla and Duckworth 2015), and action planning and commitment (Galla et al. 2016). Despite some investigation into these possible predictors of mindfulness practice, the determinants of other health-supporting behaviors have been more thoroughly investigated and may help to shed light on additional predictors of mindfulness practice.

Accounting for and specifically targeting known theoretical determinants of a behavior can improve the effectiveness of interventions intended to change that behavior (Chatzisarantis and Hagger 2005; Hardeman et al. 2002; Riebl et al. 2015). One prominent theory in behavior change literature is the Theory of Planned Behavior (TPB; Ajzen 1991), which posits that attitudes (i.e., beliefs related to the consequences of the behavior and the evaluation of the importance of those outcomes), perceived norms (i.e., beliefs regarding what others think one should do), and perceived behavioral control (i.e., beliefs regarding one's ability to effectively perform the behavior) predict one's intention to perform a behavior, and that intention in turn explains behavioral performance. The reasoned action approach (RAA; Fishbein and Ajzen 2010), an extension of the TPB, incorporates additional theoretical constructs described later. Meta-analyses indicate that the TPB and RAA predict intention and behavior relatively well, both cross-sectionally and prospectively, in various populations (e.g., Armitage and Conner 2001; McEachan et al. 2011; Sheeran and Taylor 1999; Sheeran et al. 2016), and these theories have been used to predict a number of health behaviors, including physical activity, diet, screening behaviors, and condom use (Ajzen 2015; Albarracin et al. 2001; Cooke and French 2008; Hagger et al. 2002; McEachan et al. 2011).

When it comes to predicting mindfulness practice however, only some components of the RAA have previously been investigated. As mentioned earlier, Malinowski (2013) used intention, expectations, and attitudes to predict mindfulness practice in his model, and Stanley et al. (2011) also tested attitudes toward the mindfulness training program as a predictor of mindfulness practice. The impacts of perceived behavioral control and perceived norms on mindfulness practice have not been previously investigated, although the RAA holds that they too are significant to the prediction of behavior.

In the RAA, perceived norms were expanded to consist of not only injunctive norms (i.e., perceptions about what others think a person should do) as in the TPB but also descriptive norms (i.e., perceptions of what others are actually doing), which McEachan et al. (2016) have demonstrated to have substantial predictive power of intention to perform the behavior. Descriptive norms could be particularly important in explaining behavior among adolescents, where behavioral patterns are not fully developed and the perceived need for conformity is heightened (Knoll et al. 2015). Indeed, descriptive norms predict behavior better among younger samples than among older samples (Rivis and Sheeran 2003).

As the frequency of independent mindfulness practice after school-based interventions predicts positive outcomes (Carmody and Baer 2008; Huppert and Johnson 2010; Kuyken et al. 2013), it is critical to implement school-based mindfulness programs that foster maintenance of mindfulness practice after these programs end. Applying behavioral theory to this problem (see Fig. 1) may lead to positive outcomes and increase rates of mindfulness practice. In this study, we take an approach that is commonly used in developing theory-based behavior change interventions in other domains (e.g., physical activity, diet). This includes using existing data to understand important theoretical predictors of a behavior (i.e., mindfulness practice) and subsequently using this understanding to develop an intervention that changes these predictors *en route* to changing behavior.

The present paper describes two studies which were embedded within a larger trial of a school-based mindfulness intervention called healthy learning mind (HLM; Volanen et al. 2016, 2018). HLM is a 9-week school-based mindfulness program delivered to adolescents aged 12–15. It is based on the ".b" (pronounced "dot b") program developed in the UK (Kuyken et al. 2013) and consists of classroom-based lessons covering different mindfulness techniques. HLM was tested in a large cluster-randomized controlled trial (cRCT) among 56 schools in southern Finland in order to examine its effects on mental well-being (e.g., resilience, depressive symptoms, and total difficulties), cognitive functions, psychophysiological responses, and academic achievement at post-treatment, 6-month, and 1-year follow-ups (Volanen et al. 2016, 2018). The HLM trial was not conducted in all schools simultaneously, but rather over the course of four trial periods

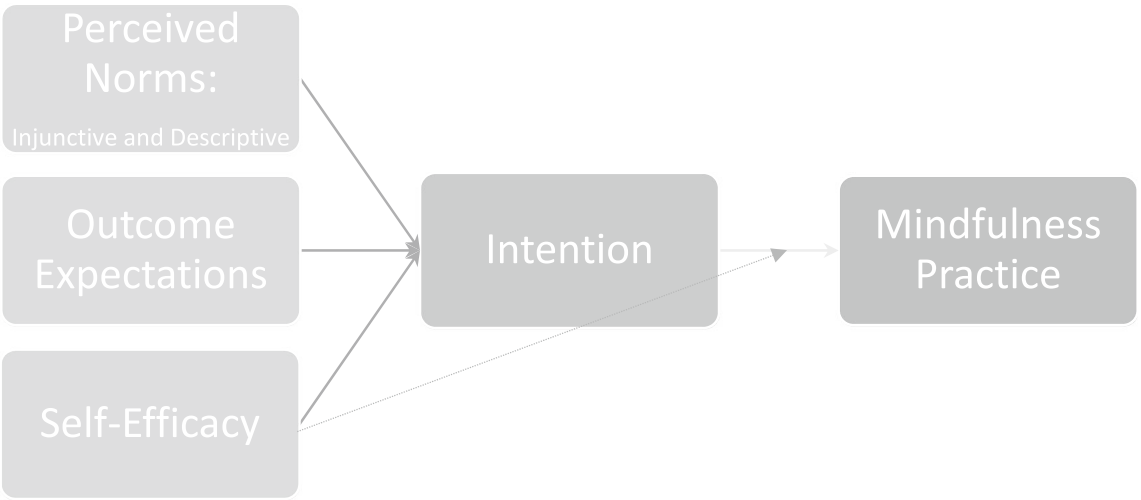

Fig. 1 Applying Ajzen's and Fishbein's theory to mindfulness practice

(i.e., batches), which allowed for the analysis of one batch to inform the creation of a booster that was delivered in a subsequent batch. In this paper, Study 1 examines the utility of an extended RAA model to explain mindfulness practice and investigates students' self-reported reasons for non-practice in the first batch of the HLM cRCT. Based on this, a booster intervention was developed and implemented during the third batch of the HLM cRCT. Study 2 examines the feasibility of this booster intervention and explores its effects on students' intentions for mindfulness practice and mindfulness practice itself, in a small-scale within-trial cRCT within the third batch of the HLM study. See Fig. 2.

Study 1

Method

Participants

The participants in Study 1 were 310 middle school students who received the HLM intervention during the first batch of the HLM trial. Participant characteristics are presented in Table 1.

Procedure

Within the HLM cRCT, 247 schools from Southern Finland were invited to participate, of which 56 accepted the invitation and enrolled in the study. After entering the study, schools were matched according to language used for teaching (i.e., Finnish, Swedish, or English), grade, and school location and were then randomly allocated to a mindfulness intervention group (85 total classes), an active control group (79 total classes), or a no-treatment group (28 total classes). Of the 10 schools that participated in the first batch of the HLM trial (spring 2014), analyzed here in study 1, five schools were allocated to the HLM program. Data were collected at baseline, at 5 weeks (intervention arm only), immediately after the 9-week intervention (via a feedback form), around 10 weeks from baseline, and 6 months after baseline from the adolescents, their parents, and teachers (Volanen et al. 2016, 2018). This study uses data collected at 10 weeks and 6 months. See Fig. 3 for a flow chart of Study 1.

Fig. 2 Timeline of present studies with reference to HLM

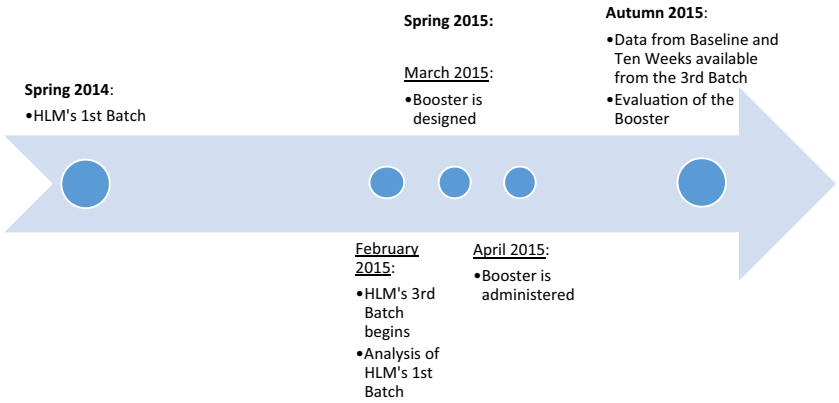

Table 1 Demographics of the intervention arm of HLM's first batch

		First Batch	
		Frequency	Percentage
Gender	Girls	134	43
	Boys	137	44
	Missing	39	13
Mother tongue	Finnish	258	83
	Swedish	0	0
	Other	13	4
	Missing	39	13
Total		310	100

Measures

Outcome expectations were measured at 10 weeks with six items, each responded to on a five-point scale ranging from "totally disagree" to "totally agree." The item stem was: "The ability to relax and calm my mind when I'm stressed, nervous or anxious …," which was followed by these items: "1. Can help me feel better," "2. Can help me be healthier," "3. Can help me learn," "4. Can help me perform better (e.g., in sports)," "5. Does not help me in any way," "6. Takes time from other important things." The last two items were reversed-scored, and the mean of all items was taken as the score for outcome expectations. It should be noted that this measure (as well as the measure of self-efficacy for mindfulness practice) uses "the ability to relax and calm my mind" as a proxy for mindfulness exercises or practice, which limits conclusions drawn from this measure.

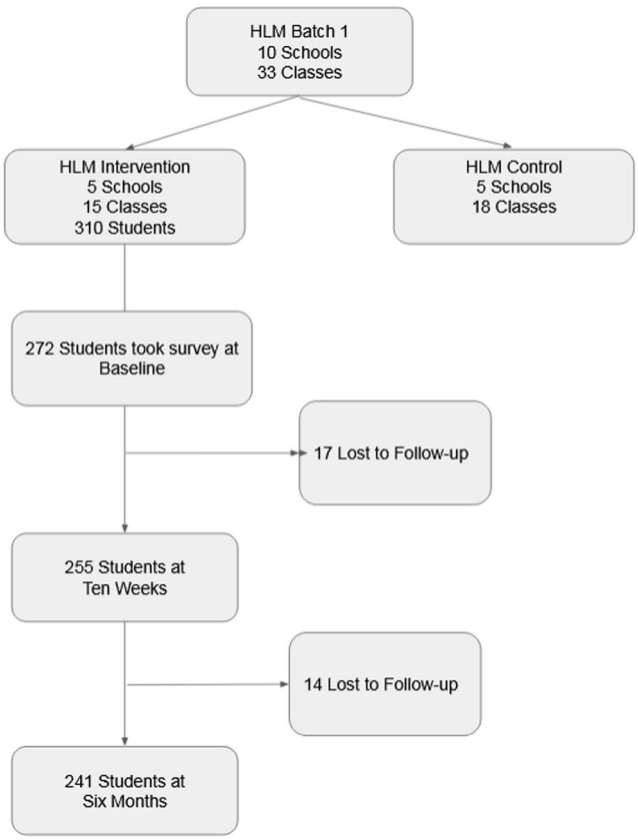

Fig. 3 Study 1's flow chart

Perceived norms were measured by three items, including descriptive and injunctive norms, on a five-point scale ranging from "totally disagree" to "totally agree" on the 10-week survey. Descriptive norms about peers' mindfulness practice were measured with the item: "1. My friends do some of the exercises we learned," and injunctive norms with the average of the items: "2. My friends think that it's OK that I do the home exercises," and "3. My parents think that it's OK to do the exercises I have learned."

Self-efficacy was measured by a mean of four items on a four-point scale ranging from "I am certain I cannot" to "I am certain I can" on the 10-week survey. The question and item stems were: "I think I can calm my mind, even when …," "1. I have an important test or speech in school," "2. I'm stressed or in a bad mood," "3. I have to perform in sports, music, etc. outside school," and "4. I have quarreled with someone/some people who are close to me."

Intention to practice mindfulness was assessed with a single item in the ten-week survey which read: "During the next months, I intend to use the exercises I have learned to relax and calm my mind." Respondents answered on a seven-point scale ranging from "totally disagree" to "totally agree." Due to a non-normal distribution, intention was categorized into those who disagreed with the intention statement and those who agreed or neither disagreed nor agreed.

Frequency of mindfulness practice in the past month on the 6-month survey was assessed with four items describing exercises taught in the HLM curriculum. Participants responded to the stem, "Think about the past one month (four weeks) and answer the following questions. During the past one month I did the following exercises at home …" on a five-point scale ranging from "not once" to "almost every day or every day." The exercises were as followed: "1. Short breathing exercises that lasted under 10 minutes (e.g., breathing 7/11)," "2. Long breathing exercises that lasted over 10 minutes," "3. Movement relaxation (e.g., the Move in the wind—exercise, walking mindfully)," and "4. Mindfulness in everyday tasks (eating, brushing teeth etc.)." A total frequency score was calculated by taking the mean of responses to these four items. As this variable was skewed, it was categorized into those who had not practiced at all and those who had practiced at least once.

Self-reported reasons for not practicing mindfulness exercises were assessed at 6 months by asking respondents: "If you have not done any mindfulness exercises during the past half year, what do you think are the reasons for this? Choose all that apply": "1. I didn't find them useful," "2. The

exercises were too difficult," "3. I have forgotten to do the exercises," "4. I have been too busy to do the exercises," "5. I think the exercises are boring," "6. I have not needed the exercises," and "7. Other, please specify" (open-ended question).

Data Analyses

Two of the main variables under study were not normally distributed. Intention had a kurtosis score of − 1.22 and a bimodal distribution, and practice at 6 months had a skewness score of 2.82 and a kurtosis score of 10.13. Due to the non-normal distributions of intention and practice at 6 months (Field 2017; Lei and Lomax 2005), these variables were dichotomized into two groups using a median split. As self-efficacy, perceived norms, descriptive norms, and outcome expectations were distributed normally, they were not recoded and remained continuous. Consequently, logistic regression analyses examined the extents to which these predicted mindfulness practice at 6 months, using the recoded dichotomous intention and mindfulness practice variables.

Results

In the first batch of the HLM trial, 60% of the 310 students reported no mindfulness practice at the 6-month follow-up. The other 40% of students reported practicing mindfulness once or twice in the past month. Students' ages ranged from 12 to 15 (see Table 1 for more demographic information). Overall, the reliability of the measures was good, with Cronbach's alphas ranging from .88 to .67 (See Table 2). The most frequently reported reason for not practicing mindfulness was not finding mindfulness practice to be helpful (32% of participants; see Table 3).

Neither outcome expectations ($\beta = -.014$, $p = .943$), injunctive norms ($\beta = -.112$, $p = .894$), self-efficacy ($\beta = -.201$, $p = .408$), nor intention ($\beta = -.529$, $p = .116$) predicted mindfulness practice. However, descriptive norms did ($\beta = .497$, $p = .002$). The model (Nagelkerke's $R^2 = .11$) fit well ($\chi^2(5) = 20.77$, $p = .001$). Parametric regression analyses with non-dichotomized variables showed comparable results, except that in these analyses, intention did significantly predict mindfulness practice.

Table 3 Frequencies and percentages of given reasons for non-practice in study 1 ($N = 213$)

Reason	Frequency	Percentage (%)
Not helpful	100	32.3
Exercises too difficult	4	1.3
Forgot to do exercises	67	21.6
No time to do exercises	50	16.1
Exercises were boring	43	13.9
No need for exercises	66	21.3
Other reason	15	4.8

Note. Those who practiced would not have chosen a reason, but are still included in the percentages. This is not a percentage of only those who did not practice due the way in which the item was phrased

Discussion

To conclude, descriptive norms predicted mindfulness practice during the past month at the 6-month follow-up. Self-efficacy, outcome expectations, and intention, as operationalized here, did not predict mindfulness practice. However, another operationalization of outcome expectations, namely, students not finding the mindfulness exercises to be helpful, was the most frequently given reason for not practicing mindfulness. This pointed to the possibility that demonstrating the advantages and benefits of mindfulness practice in this population might help to improve outcome expectancies and therefore also increase mindfulness practice. Therefore, descriptive norms and outcome expectations (perceived helpfulness) were chosen as the targets for the booster intervention developed and tested in Study 2.

Table 2 Means, standards deviations, and Cronbach's alphas for study one's measures

Measure	Mean	SD	Range	Cronbach's α
Use of mindfulness exercise to relax (baseline)	1.40	.58	3	N/A
Lesson attendance	8.08	1.20	8	N/A
Outcome expectations	3.59	.86	4	.875
Perceived norms	3.14	.86	4	.671
Descriptive norms	2.39	1.08	4	N/A
Self-efficacy	2.96	.62	3	.847
Intention	3.41	1.90	6	N/A
Practice at home (6 months)	1.32	.64	4	.869

Total sample $N = 310$. All variables measured at the 10-week survey (post-treatment) unless otherwise indicated. N/A = not applicable for single-item measures

Study 2

Method

Participants

See Table 4 for demographic information about the sample.

Procedure

The newly developed booster intervention was evaluated in a within-trial cRCT within the third batch of the main HLM cRCT and only included classes that had been allocated to receive the HLM intervention ($k = 25$). Classes allocated to the mindfulness treatment arm of the main HLM intervention were stratified by intervention provider and class size by the study coordinator of the HLM program. Subsequently, classes were block-randomized, using an online tool available from random.org, to be the comparison group and receive the mindfulness intervention alone (HLM Only; 12 classes containing 152 total students) or to receive a modified version of the mindfulness intervention, which included a booster intervention delivered during the eighth and ninth sessions (HLM + booster; 12 classes containing 177 total students). One class was excluded from intervention delivery because of low participation in intervention sessions. Other researchers were blinded from the randomization until after all analyses had been conducted, and student recipients were also blinded from randomization. Only data from the surveys at baseline and 10 weeks were available for this analysis. See Fig. 4 for the flow chart.

Based on the findings of Study 1, which revealed that descriptive norms and outcome expectations were the main predictors of mindfulness practice, a booster intervention was developed to be implemented during the last two sessions of the HLM intervention—this was due to time considerations, as the third batch of the main trial had already started. During the penultimate session (session 8), 5 min was available for the present booster intervention. It consisted of two parts: a slideshow presenting peer benefits and a motivational video showing peers' experience of mindfulness practice.

The slideshow presentation displayed the percentages of peers who had experienced specific benefits after having practiced mindfulness at least once after the intervention: "79% have reported better concentration while in class," "76% have reported better concentration in their hobbies," "69% have reported managing stress better," "77% have reported coping with difficult emotions (e.g., fear, aggression, anxiety) better," "79% have reported sleeping better," "75% have reported getting better grades," "84% have reported getting along better with family members," and "85% have reported getting along better with friends." This presentation targeted both descriptive norms (i.e., that they have peers who are practicing mindfulness) and perceived benefits of practicing mindfulness.

The second part of session 8 was a video from Kelty Mental Health Resource Centre called (Kelty Mental Health 2013). The video presented peers (or adolescents slightly older) commenting on their own experiences of mindfulness practice and its benefits. In this way, both descriptive norms and perceived benefits were again targeted. This is also supported by another theory in another way: according to Self Determination Theory (SDT), people are more likely to adopt values and behaviors promoted by those to whom they feel connected and in whom they trust. Using peers to describe the benefits of mindfulness practice might thus have fostered students' need for relatedness and thus have helped to internalize the information and enhance their self-determination and motivation for mindfulness practice (Deci and Ryan 1985).

During the last session (session 9), 10 min was available for the booster intervention, which consisted of two parts: the Identifying Personal Motives Group Activity (Hankonen et al. 2017) and a benefits and practice matching sheet. The card sorting activity was completed first in small groups of four to five students, and it targeted both descriptive norms (i.e., showing that students' peers intended to practice mindfulness) and perceived benefits (through discussing and sharing

Table 4 Demographic information for study 2

		HLM Only		HLM + booster	
		Frequency	Percentage	Frequency	Percentage
Gender	Girls	89	50.3	59	38.8
	Boys	64	41.8	64	42.1
	Missing	24	13.6	29	19.1
Mother tongue	Finnish	144	81.4	121	79.6
	Swedish	0	0	1	0.7
	Other	8	4.5	1	0.7
	Missing	25	14.1	29	19.1
Total		177	100	152	100

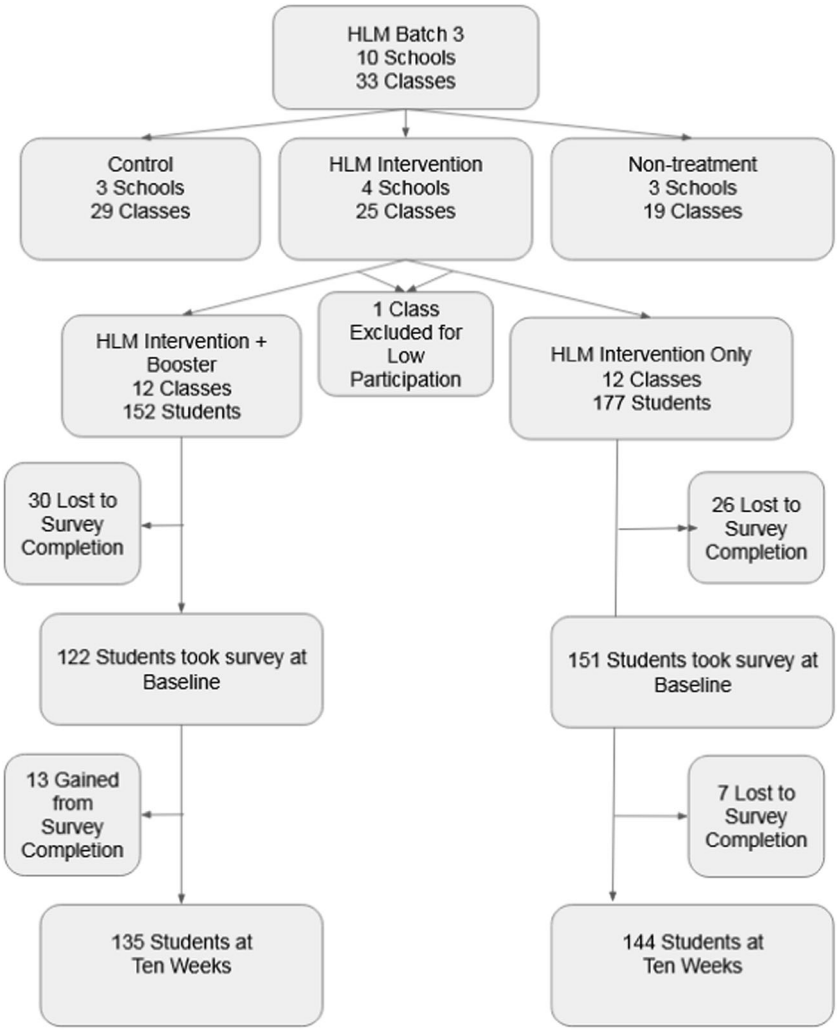

Fig. 4 Study 2's flow chart

personally relevant benefits). After dividing into small groups, each group was given an identical set of cards, with each card naming a potential benefit of mindfulness practice. Cards were color-coded for different categories of benefits (i.e., focus, positive emotions, acceptance, life-management, relationships, and others). Students were asked to choose one to three cards that described the benefit(s) that they would like to obtain by practicing mindfulness. After choosing their cards, each group shared their choices with the rest of the class. This Identifying Personal Motives Group Activity has been used previously in the Let's Move It intervention to promote physical activity among adolescents (Hankonen et al. 2017).

The benefits and practice matching sheet (see supplementary materials) targeted perceived benefits by listing the known benefits of mindfulness practice and allowing the students to define their own goals and ways to achieve them. In this way, the benefits and practice matching sheet task also fostered students' experience of autonomy, which, according to SDT, is a basic psychological need leading to self-determined motivation. The left side of the matching sheet contained boxes describing numerous potential benefits of mindfulness practice, which were color-coded in the same way as in the card sorting activity, while the right side of the sheet contained boxes that listed each of the mindfulness exercises that students had learned during the past 9 weeks as part of the mindfulness intervention. Students were instructed to choose one to two benefits they would like to receive by practicing mindfulness and to draw a line connecting each potential benefit with the mindfulness exercises they thought would most likely help them to achieve the chosen benefits ("if I want'… 'then I will do the following practice"). After making their selections and if-then plans, students were encouraged to take the sheet home and place it somewhere visible to remind them of their personal goals and plans. The benefits and practice sheet is an adaptation of the volitional help sheet (VHS), which is a tool designed to enhance the construction of effective implementation intentions (Armitage 2008). VHS has been used successfully in interventions targeting health behavior changes in smoking (Armitage 2008), drinking (Arden and Armitage 2012), and physical activity (Armitage and Arden 2010). See Table 5 for a delineation

Table 5 Booster activities, theoretical determinants, and associated behavior change techniques

Session	Booster intervention activities	Targeted theoretical determinants	Behavior change techniques
8	➢ PowerPoint presentation of data about peer practice and mindfulness benefits ➢ Video of interviews with practicing peers explaining some mindfulness benefits	➢ RAA: descriptive norms and outcome expectations ➢ SDT: relatedness	➢ 5.1. Information about health consequences ➢ 5.3 Information about social consequences ➢ 5.6 Information about emotional consequences ➢ 6.1 Demonstration of the behavior ➢ 15.1 Verbal persuasion about capability ➢ 16.3. Vicarious consequences
9	➢ Mindfulness benefits discussed with cards in a group activity ➢ Benefit and mindfulness exercise matching sheet	➢ RAA: descriptive norms and outcome expectations ➢ SDT: relatedness and autonomy	➢ 1.1 Goal setting (behavior) ➢ 1.3 Goal setting (outcome) ➢ 5.1. Information about health consequences ➢ 5.3. Information about social and environmental consequences ➢ 5.4. Information about emotional consequences ➢ 6.3. Information about others' approval ➢ 13.2 Framing/reframing ➢ 5.2 Salience of consequences

Note. The behavior change techniques are based on the behavior change technique taxonomy v1 by Michie et al. (2013)

of the concepts behind the components of the booster intervention and Table 6 for a description of the booster.

Measures

Most measures were the same as in Study 1, but there were some exceptions as described below.

Outcome expectations were measured by a mean of the four items available at baseline and 10 weeks on a five-point scale ranging from "totally disagree" to "totally agree." The item stem was: "What do you think about the following? The ability to relax and calm my mind when I'm stressed, nervous or anxious …" The items were as follows: "1. Can help me feel better," "2. Can help me be healthier," "3. Can help me learn," and "4. Can help me perform better (e.g., in sports)." The fifth and the sixth items used in Study 1 were only present in the 10-week survey, so they were omitted in Study 2.

To assess their use of a mindfulness exercise to relax, participants were queried with the stem, "How often do you do the following activities to relax?" and participants then responded to one item "I do a mindfulness exercise" with possible responses of: "Not at all," "Seldom," "Sometimes," and "Often."

Motivation for learning to relax and calm one's mind was measured with a single item that read "I would like to learn to relax and calm my own mind better." Responses were given on a five-point Likert scale ranging from "disagree" to "agree." Similar to outcome expectations and self-efficacy, this measure also did not explicitly state mindfulness practice as the object.

Practice at home at 10 weeks (during the program) was used to operationalize the targeted behavior. Respondents were asked how often they practiced the mindfulness exercises at home, with the item stem "I practiced …": "1. Counting breaths in one minute," "2. … seated body-scan," "3. Breathing 7–11," "4. Beditation (body-scan)," "5. Mindful breathing (paying attention to sensations of breath)," "6. Mindful eating," "7. .b (pausing and breathing)," "8. Walking mindfully," "9. Watching thoughts pass by as if they were traffic," "10.Seeing thoughts as clouds passing through the mind," "11. Feeling my feet on the floor (when I feel stressed or anxious)," "12. Breathing relaxation (e.g., the balloon-exercise)," "13. Relaxation through imagery (e.g., the beach-exercise)," and "14. Movement relaxation (e.g., the move in the wind-exercise)." The six-point scale ranged from "many times a day" to "not once" and was reversed scored. These items were averaged into a mean practice-at-10-week score.

Data Analyses

Outcome expectations, use of a mindfulness exercise to relax, intention, and practice of mindfulness were non-normally distributed, and so changes and differences in these variables were assessed with non-parametric tests, in addition to parametric tests. Outcome expectations at baseline had a skewness score of − 1.086 and a kurtosis score of 1.727. Use of a mindfulness exercise to relax at baseline had a skewness score of 1.179 and a kurtosis score of .84. Intention had a kurtosis score of − 1.34 and a bimodal distribution. Practice at 6 months had a skewness score of 2.13 and a kurtosis score of 3.88. Finally, lesson participation had a skewness score of − 1.48 and a kurtosis score of 3.23. These non-normally distributed variables were recoded into variables with two to three categories having relatively equal numbers of participants.

Table 6 Description of the booster intervention using the TIDieR checklist (Johnston 2014)

Item number and label	Booster intervention
1. Brief name	A motivational booster intervention to increase students' mindfulness practice
2. Why	To increase mindfulness practice at home. The TPB provided suggestions for how to increase practice.
3. What materials	➢ Slides on what benefits practicing peers receive ➢ Mindfulness: Youth Voices video: https://youtu.be/uOrDmRhwBR8 ➢ Cards with benefits associated with mindfulness practice written on them ➢ Mindfulness Benefits and Exercises Matching Sheet
4. What procedures	One session explaining benefits peers who practice receive and one session encouraging participants to choose benefits and exercises for themselves
5. Who provided	Four facilitators who administered the intervention had a background in mindfulness and practiced themselves. Training for the booster intervention: They had attended a two-hour training session delivered by two behavioral scientists and received a manual with scripts to use when addressing the students and assigning the task.
6. How	Mode of delivery: face-to-face, group
7. Where	Schools in southern Finland
8. When and how much	➢ embedded in the HLM mindfulness program's final 2 sessions ➢ 1 week interval between the sessions ➢ 5 min in the first and 10–20 in the second
9. Tailoring	Materials were tailored to be age-appropriate and to fit within the allotted time for delivery, but no individual-level tailoring was included.
10. Modifications	Not measured systematically.
11. How well-planned	Facilitators were given a checklist and an open-ended comment box to fill in with the materials. Additional, more specific questions were asked 9 months after.
12. How well actual	Not measured systematically.

Practice of mindfulness, use of a mindfulness exercise to relax, and intention were recoded into the presence or absence of any practice or intention. Outcome expectations were recoded into "totally disagree" to "neither agree nor disagree," "agree a little," and "agree." Lesson participation was recoded into nine lessons, eight lessons, and less than eight lessons. Change scores were first calculated for retesting the mixed ANOVA variables before they were recoded.

Independent samples t tests (for normally distributed variables), Mann-Whitney U tests, and chi-square tests were used to examine baseline differences between the HLM Only and HLM + booster groups. Within-group changes in outcomes were assessed using paired t tests for normally distributed variables, and Wilcoxon signed-rank tests for non-normally distributed variables. Mixed within-between ANOVA tests were used to examine differences in trajectories between the HLM Only and HLM + booster groups over time in normally distributed variables for which both baseline and 10-week data were available. For non-normally distributed variables, change scores were calculated, the change scores were recoded into variables with two to three categories, and then analyzed in chi-square tests as in Study 1. Between-groups differences at 10 weeks were assessed using Mann-Whitney U tests for variables for which no baseline data were available.

Results

At baseline, there were no differences between the HLM Only and HLM + booster groups on outcome expectations ($\chi^2(2, n = 170) = 1.26$, $p = .532$), motivation to relax and calm one's mind ($t(263) = -.864$, $p = .385$), or use of a mindfulness exercise to relax ($U = 8409$, $p = .475$). There were also no differences between groups in their levels of lesson attendance within the HLM program ($\chi^2(2, N = 258) = 1.18$, $p = .556$).

Within the HLM Only group from baseline to post-treatment, outcome expectations significantly decreased ($Z = -3.059$, $p = .002$), use of a mindfulness exercise to relax significantly increased ($Z = -3.059$, $p = .003$), and motivation to relax and calm one's mind increased, albeit not significantly ($t(127) = -.839$, $p = .403$). Within the HLM + booster group, outcome expectations also decreased ($Z = -2.037$, $p = .042$), use of a mindfulness exercise to relax also increased ($Z = -2.893$, $p = .004$), and motivation to relax

and calm one's mind decreased non-significantly ($t(105) = .204$, $p = .839$). See Table 7.

For variables with both baseline and 10-week data, mixed within-between ANOVA's examined differences in trajectory over time between groups. These revealed no statistically significant differences in trajectory over time between groups in either use of a mindfulness exercise to relax ($\chi^2(6, N = 230) = 4.47$, $p = .613$) or motivation to relax and calm one's mind ($F(1,232) = .535$, $p = .465$). However, use of a mindfulness exercise to relax increased (non-significantly) more for the HLM + booster group than for the HLM Only group. Outcome expectations decreased significantly less for the HLM + booster group than for the HLM Only group ($\chi^2(4, N = 205) = 12.23$, $p = .016$).

For variables without baseline data, data at 10-weeks were compared across groups. These analyses revealed no statistically significant differences at post-treatment between the HLM Only and HLM + booster groups on descriptive norms ($U = 8801$, $p = .361$), intention to use mindfulness exercises ($U = 9377$, $p = .680$), or self-reported mindfulness practice ($U = 9283$, $p = .519$). See Table 7.

In comparison to non-parametric tests, parametric tests showed the same results with one exception: the decrease in outcome expectations was not statistically significantly greater in the HLM Only than in the HLM + booster.

Discussion

Based on the results of study 1, our group developed a booster intervention that targeted outcome expectations and descriptive norms of friends practicing mindfulness as determinants of intention to practice mindfulness and mindfulness practice itself. This intervention resulted in increased use of mindfulness exercises to relax within the HLM + booster group. However, when compared to the HLM Only group, these changes were not significantly more favorable in the HLM + booster group. Outcome expectations on the other hand were shown in the mixed tests to decrease significantly less in the HLM + booster group.

General Discussion

Accounting for and specifically targeting known theoretical determinants of a behavior can improve the effectiveness of behavior change interventions (Chatzisarantis and Hagger 2005; Hardeman et al. 2002; Riebl et al. 2015). As such, this article examined the TPB and RAA as a theoretical framework for increasing intention to practice mindfulness and mindfulness practice itself.

Of the RAA determinants assessed in Study 1, descriptive norms (i.e., what friends are doing) and perceived

Table 7 A summary of within, between, and mixed tests' results

	Cronbach's α	HLM Only group			HLM + booster group				
		Baseline	10 weeks	p_{within}	Baseline	10 weeks	p_{within}	$p_{between}$	p_{mixed}
Outcome expectations	0.928	3.97 (0.84), 4, 142	3.75 (0.80), 4, 131	0.002^{W*}	3.85 (0.92), 4, 122	3.82 (0.73), 3.25, 116	0.042^{W*}	–	0.016^{C*}
Descriptive norms	N/A	No data	2.31 (1.05), 4, 142		No data	2.40 (1.08), 3, 132	–	0.361^{M}	–
Motivation	N/A	3.15 (1.19), 4, 128	3.27 (1.21), 4, 128	0.403^{T}	3.27 (1.12), 4, 106	3.25 (1.17), 4, 106	0.839^{T}	–	0.465^{A}
Intention	N/A	No data	3.72 (1.98), 6, 144		No data	3.61 (2.08), 6, 134	–	0.680^{M}	–
Use of mindfulness to relax	N/A	1.61 (0.80), 3, 148	1.78 (0.83), 3, 142	0.003^{W*}	1.50 (0.65), 2, 119	1.73 (0.88), 3, 131	0.004^{W*}	–	0.613^{C}
Home practice of mindfulness	.924	No data	1.99 (1.06), 5, 145		No data	1.97 (1.13), 5, 134	–	0.519^{M}	–

Note. All values are presented as mean (SD), range, *n*. * = value differs significantly from baseline (paired *t* test $p < 0.05$), ^{M} = Mann-Whitney *U* test, ^{C} = a chi-square test, ^{W} = Wilcoxon signed-rank test, ^{A} = mixed within-between ANOVA, and ^{T} = paired samples *t* test

benefits were found to predict adolescents' mindfulness practice. These results are in line with evidence from other health behaviors that point to descriptive norms as important predictors of behavior (McEachan et al. 2011, 2016). Perceived benefits have also been linked with other health behaviors in adolescents (e.g., Hankonen et al. 2013; McEachan et al. 2011). Although descriptive norms of practicing and perceived benefits of mindfulness practice predicted mindfulness practice in this study, self-efficacy and one measure of outcome expectations did not. This could be due to the operationalization of these constructs, as the item stems pointed to the perceived self-efficacy to relax and calm one's mind, as opposed to self-efficacy for engaging in sustained mindfulness practice. Hence, the self-efficacy measure used here may indeed be a reflection of the perceived ability to calm one's mind and not of the perceived self-efficacy to engage in mindfulness practice. If participants thought they could already calm their minds, then that could explain why they did not find the mindfulness exercises helpful.

This paper presents the development of a theory-based behavior change intervention to promote practice of mindfulness exercises after the completion of a formal mindfulness program. It was expected that successfully targeting these determinants would increase students' intention to take up the practice of mindfulness, but this was not shown, perhaps due to the small dose of the booster intervention and low statistical power.

The booster intervention had minimal effects on theoretical determinants of mindfulness practice. Over the course of the intervention, outcome expectations decreased within both groups, albeit non-significantly. Qualitative interviews could perhaps help shed more light on how this change in outcome expectations took place. At 10 weeks, there was no significant difference between the HLM + booster and HLM Only groups' intention levels, which is unsurprising as descriptive norms and outcome expectations did not increase. Motivation for learning to relax and calm one's mind, a construct related to intention that was also available at baseline and 10 weeks, did not significantly change following the intervention either. One reason for this minimal effect may be the small sample size or the failure of the session facilitator to deliver all the booster intervention components as intended.

Had the booster intervention tested here targeted all RAA constructs (e.g., self-efficacy), it may have led to greater changes in students' intention and ultimately mindfulness practice. The booster intervention also did not include any elements of action planning (i.e., having students plan when, where, and how they will practice the learned exercises), which has frequently been utilized in effective adolescent health behavior change interventions (Galla et al. 2016; Hynynen et al. 2016). Future studies should add action planning to motivational interventions to investigate whether this yields better results in increasing mindfulness practice.

The booster intervention was limited to some extent by the short window of time in which it could be delivered. Because of this, the HLM Only had around 15 min of extra time in the main mindfulness intervention, which meant more time to learn the exercises and perhaps about benefits. Seeing their peers practicing would have influenced the descriptive norms of friends practicing. Because of this, it may not have sufficiently worked as a "comparison group."

Use of a mindfulness exercise to relax increased for both HLM Only and HLM + booster from baseline to 10 weeks and the increase was even greater for HLM + booster, but these trends were statistically non-significant. Outcome expectations decreased for both arms, but less so for HLM + booster. Practice at home at 10 weeks also did not result in any statistically significant differences between HLM Only and HLM + booster. It is possible that the trends seen in outcome expectations and use of a mindfulness exercise to relax do show that the booster had some positive effect and that a higher dose could have resulted in significant effects for these variables as well as for practice.

Strengths and Limitations

The studies presented here have several important strengths. First, Study 1 investigated some untested theoretical predictors of mindfulness practice. Future research in this area, perhaps drawing from different behavioral theories, might identify additional predictors of mindfulness practice that would make good targets for interventions. Second, the brief booster intervention developed based on the results of Study 1 is a theory- and evidence-based behavior change intervention targeting practice of mindfulness with an experimental design.

This piece of research is a longitudinal cRCT with a relatively high number of participants. It applied theory in analyzing the predictors of mindfulness practice and in planning and evaluating the booster intervention to increase student's mindfulness practice. All the facilitators were themselves mindfulness practitioners. Measures were taken to assess changes both within- and between-groups. Detailed descriptions of the intervention components, including all used behavior change techniques, are reported. This study also adds to the research on applying the TPB/RAA to the design of health behavior change interventions. It also serves as a way for future researchers to estimate the effects of a minimal booster intervention on changes in mindfulness practice and can be used to inform sample size calculations for subsequent studies.

Despite the strengths of applying theory to a new behavioral domain and of following the appropriate processes for developing theory-based interventions, the studies presented here also have limitations. First, no validated TPB/RAA questionnaires for mindfulness practice existed at the outset of this study and so, the items used as assessments here

could be seen as proxy measures at best. Future research should attempt to develop and validate a TPB/RAA questionnaire specifically for mindfulness practice behaviors. The items used to measure outcome expectations, self-efficacy, and intention to practice mindfulness referenced the behavior of "relaxing and calm one's mind." Ideally, these measures would assess social cognitive determinants specifically in relation to the target behavior, with an explicitly defined context and frequency (i.e., "During the next months, I will use the mindfulness exercises I have learned (choose a time and frequency"), and use the same target behavior across the measurement of all constructs.

Secondly, the time allocated for delivery of the booster intervention sessions (i.e., roughly 15 min in total) may have been too short to have an impact. Students may need longer and/or more frequent sessions to build lasting and credible descriptive norms of peer practice and positive outcome expectations of mindfulness practice. For practical reasons, the implementation of the booster intervention was only possible during the last two sessions of the main program, although it may have been more fitting to implement the booster during the beginning to increase motivation while the students were learning and practicing mindfulness. Also, while the fidelity of delivery was not reported, personal discussions with facilitators revealed that they had made some modifications, either due to time constraints or behavioral features of the class. This means that not all booster sessions were delivered as intended, but without having undertaken any fidelity assessments, we cannot speculate on the impact this infidelity may have had on results or conduct any per protocol analyses that take into account the actual delivery of the intervention. Due to this limitation, the results should be interpreted with caution.

Finally, the questionnaires had some shortcomings. Its considerable length may have led to participant fatigue. Although, at the same time, some principal measures were not present at all time points, to avoid measurement burden.

Future research should look into the optimal length and number of booster intervention sessions, as this intervention was only composed of two sessions totaling 15 min. We also recommend more investigations into the relative importance of descriptive norms as a predictor of mindfulness practice. Intervention developers may benefit from understanding that participants who do not practice cite low perceived benefits most frequently as the reason for not practicing. It would be useful to develop more interventions that target the determinants of mindfulness practice and to combine targeting these constructs with implementation intentions. This would enable a potentially greater increase in students' intention and practice. In addition, it would be useful to study whether the determinants of mindfulness practice differ among different age and cultural groups. Future research should also aim at examining predictors of maintenance of independent mindfulness practice post-intervention with longer follow-ups than those employed here.

Acknowledgments The authors would like to thank the facilitators of the HLM program for their assistance in incorporating the booster intervention into the short time span available at the end of HLM intervention sessions as well as all involved schools and students for participating in the research.

Author Contributions MB: analyzed the data and wrote the paper. NH: conceived of the study and its design, as well as critically revised the manuscript for important intellectual content. GS: assisted with the data analyses and writing the paper. KK: made substantial contributions to study design and critically revised the manuscript for important intellectual content. SMV: as the PI of the HLM project, facilitated the data acquisition and provided guidance in the writing and editing of the manuscript. All authors read and approved the final manuscript.

Funding Information The first author and NH were supported by a grant from the Academy of Finland (#285283). The data collection was funded by the Juho Vainio Foundation, the Signe and Ane Gyllenberg Foundation, the Yrjö Jahnsson Foundation, and the Mats Brommels Foundation.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Ethics Statement All procedures performed in studies involving human participants were approved by the humanities and social and behavioral sciences ethical review board of the University of Helsinki (Statement 1/2014) as well as the department of education in the each school district. They were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants and their parents/ guardians. Participants were informed that participation was voluntary.

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