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SINGLE-STUDY PAPER

# Attention Training Improves the Self-Reported Focus and Emotional Regulation of High School Students

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Previous research points to digital attention training as a potential remedy for the growing levels of distraction and emotional distress that adolescents experience. However, no studies with a comparison group have been conducted in high school settings to assess the feasibility and efficacy of digital attention training. Using a two-group, pretest/posttest design, this study examined the effect of an online course called Finding Focus. Across three U.S. high schools, $N = 197$, classrooms were assigned to either continue with school-as-usual or to complete 2.5 hr of attention training over the course of 22 days. At pretest, data collection via online surveys showed that 77% of students reported focusing less often during class than they believed they ideally should. Compared to those in the control condition, students in the intervention condition reported at posttest adopting a stronger growth mindset regarding their ability to focus (Cohen's $d = .42$) and greater confidence that they knew how to train that ability ($d = .89$). At posttest, those in the intervention condition also self-reported less mind-wandering during class ($d = .31$) and daily life ($d = .42$), as well as higher classroom focus ($d = .29$). The intervention also led to improvements in perceived emotional regulation ($d = .37$). Collectively, these results suggest that digital interventions may be a promising and scalable avenue for improving adolescents' attention and emotional well-being.

**Keywords:** attention training, digital intervention, mindfulness, focus, emotion regulation

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Across the globe, adolescents face escalating levels of distraction and emotional distress (Twenge, Cooper, et al., 2019; Twenge et al., 2021; Twenge, Martin, et al., 2019). Although these two challenges may initially appear unrelated, attentional control is highly relevant for not only mitigating distraction but also effectively regulating emotional distress. At any given moment, students must filter through a tremendous amount of information coming both from the environment and from within their own minds. How a student uses attention to navigate this continual flood of perceptions, thoughts, and feelings has a major impact on not only their ability to focus but also their emotional experience (Creswell, 2017; Smallwood et al., 2007).

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The data are available at https://osf.io/5pfr9/.

The experimental materials are available at https://osf.io/cx3tu/.

The preregistered design is available at https://osf.io/gb6ac/.



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## Training Attention Can Reduce Distraction

The problem of distraction in educational settings is undeniable and desperately in need of viable solutions (Mrazek, Mrazek, Cherolini, et al., 2019; Rideout, 2015). One highly disruptive source of distraction is *mind-wandering*, which is defined as task-unrelated thought (Smallwood & Schooler, 2006). Mind-wandering is rampant during academic activities, where it impairs learning and task performance (Szpunar et al., 2013). For example, mind-wandering while reading reduces text comprehension (Schooler et al., 2004). Additionally, mind-wandering during lectures reduces learning and exam performance (Risko et al., 2012). Exacerbating these challenges, many students hold a *fixed mindset* about their level of mind-wandering (Zedelius et al., 2021). In general, a fixed mindset is the belief that a particular quality is an immutable trait. In contrast, a growth mindset is the belief that a trait is malleable and can be cultivated through practice (Dweck, 2006). Students hold a fixed mindset about their attention if they believe their ability to focus is something that is unchangeable. Research by Zedelius et al. (2021) suggests that the success of an attention training intervention depends on whether the participant holds a fixed or growth mindset.

In addition to a fixed mindset, another factor that can influence levels of distraction is whether students' have low or high self-efficacy about their ability to train attention (Mrazek, Mrazek, Reese, et al., 2019). To willingly engage in the development of a new skill, like attentional control, students must not only believe that the ability can be improved in theory. They also need to feel some level of confidence that they have the knowledge and tools that are necessary to train that ability (Zimmerman, 2000). Fortunately, a growing body of evidence among adults and adolescents suggests that attention training can instill a growth mindset about one's ability to focus and improve self-efficacy with respect to training attention (Mrazek et al., 2018, 2020; Mrazek, Mrazek, Reese, et al., 2019).

## Training Attention Can Reduce Emotional Distress

Emotional responses to a situation depend on how attention is directed among the various components of that situation. One of the most prominent models of emotion regulation, called *the process model* (Gross, 2015), elucidates this connection between attentional control and emotion regulation. Gross (2015) argues that a key strategy for the effective management of emotion is attentional deployment (i.e., where one chooses to direct their attention). As just one example, an individual could shift their attention away from an aspect of a situation that triggers a counterproductive emotional response and toward an aspect of that situation that is more neutral. This skillful form of intentional redirection of attention has been referred to as *refocusing* (Mrazek, Mrazek, et al., 2017). However, individuals with low levels of attentional control may struggle to refocus and instead repeatedly direct their attention toward the emotional aspects of a situation through rumination (Gross, 2015).

Another way that attention can impact emotional states is by influencing which cognitive appraisals are elaborated and which are inhibited (McRae & Gross, 2020). The evaluations that a person makes about an event can be just as influential in determining their emotional response as is the event itself. For example, if a student is taking an important test, they could evaluate it as an opportunity to learn and demonstrate their progress, or they could evaluate it as a stressful assessment of their intellect and a threat of failure. Whichever interpretation the student chooses to pay attention to will predominate in their mind and thereby shape how the student feels.

## Attention Training in Schools

Based on the research reviewed above, providing students with attention training could enhance not only their levels of focus but also their ability to effectively regulate challenging emotions. Although research into attention training within school settings is still in early stages, there is a growing body of research on mindfulness-based attention training (Emerson et al., 2020). These interventions typically involve both the development of attentional skills (e.g., how to disengage attention from a distraction) and guidance for applying these attentional skills to the observation and regulation of emotions. Although additional research in school settings is needed, the existing evidence does suggest that attention training can elicit a variety of benefits for students, including reduced mind-wandering, enhanced performance on academic tasks, improved emotional regulation, and greater overall mental health (Carsley et al., 2018; Lahtinen & Salmivalli, 2020; Mrazek et al., 2020; Mrazek, Mrazek, Reese, et al., 2019; Mrazek, Zedelius, et al., 2017).

While training attention represents a promising approach for improving the academic focus and well-being of adolescents, very few high school students receive this kind of training (Laukkonen et al., 2020). To broadly empower high school students with these skills, schools would need scalable and evidence-based training programs that can be feasibly delivered in classrooms. Digital interventions are a potentially promising solution because they circumvent many of the logistical constraints of conventional interventions (Mrazek, Mrazek, Cherolini, et al., 2019).

## Advantages and Challenges of Digital Interventions

A digital approach has at least four advantages over conventional interventions. First, digital interventions reduce geographical and financial constraints that would otherwise limit equitable access (Devine et al., 2018). Second, digital interventions allow for the standardization of key content, thereby ensuring all students receive the same high-quality instruction (Kenney et al., 2004; Puzziferro & Shelton, 2008). Third, digital interventions can provide content that is personalized to the abilities, interests, and values of individual students, thereby promoting student engagement, cultural responsiveness, and effective learning (Dixson, 2010; Wang, 2014). Fourth, and surprising to many, well-designed digital interventions can elicit equal or even greater benefits than in-person training. For example, one study found that both digital and face-to-face mindfulness interventions were equally effective in helping reduce perceived levels of depression, anxiety, and stress (Krusche et al., 2013).

However, the advantages of a digital intervention are difficult to achieve because they require meticulous design and effective execution in real-world settings. For both digital and nondigital interventions, ensuring high-fidelity of implementation (FOI) in school settings is challenging. In one of the few published reports examining the effectiveness of digital attention training in a high school setting, only 1 of 85 students completed the full intervention (Antonson et al., 2018).

Two more recent studies have shown greater promise for the feasibility of digital attention training in high schools. These studies examined the FOI and outcomes of an online course called Finding

Focus, which was shown to improve students' classroom focus and emotional regulation (Mrazek et al., 2020; Mrazek, Mrazek, Reese, et al., 2019). However, these studies relied on one-group designs without a control group, making it difficult to rule out alternative explanations for the observed improvements such as maturation or time-of-year effects.

### Overview of the Present Study

Given that attentional control can help mitigate the issues of both distraction and emotional distress, the present investigation was designed to more rigorously evaluate the Finding Focus intervention in a research study across three high schools. This study compared students who completed the intervention to students who continued with school as usual, collecting self-report survey data from all students both before and after the intervention was administered. This provided the opportunity to assess any changes in students' self-reported perceptions of their own experiences that resulted from the intervention.

Based on prior research described above, an attention training intervention is more likely to be effective if it can help students believe that attention is a trainable skill (growth mindset) and feel confident in training and using their attention well (self-efficacy). If the intervention is effective, results should show reductions in mind-wandering and increases in classroom focus, as well as improvements in emotional regulation. Accordingly, this study had five preregistered hypotheses. Compared to students in the control group, we predicted that students who received the intervention would self-report: (a) a stronger growth mindset about the ability to focus, (b) increased self-efficacy in knowing how to improve focus, (c) reduced mind-wandering during academic activities and daily life, (d) improved classroom focus, and (e) improved emotional regulation.

## Method

### Research Design

This study used a two-group, pre-test/post-test design. The sample included students at three public high schools in the United States. At each school, one teacher who had prior experience using Finding Focus agreed to have their classrooms assigned to condition. Two schools had three participating classrooms, and one school had five participating classrooms. Given these differences, it was not possible to achieve equivalent sample-size across conditions. Classrooms were assigned to condition in the manner that minimized discrepancy in sample-size cross conditions within each school. Nevertheless, there was an unavoidable discrepancy in sample sizes across conditions, which was weighted toward more students in the intervention condition. In total, seven classrooms were assigned to the intervention condition and four classrooms were assigned to school-as-usual. The research was approved by the Human Subjects Committee under the institutional review board (IRB) number 5-21-0350 at the University of Santa Barbara, and opt-in informed consent was obtained from all students and their guardians.

### Participants

Across the three high schools, 293 students completed the pretest. Of those students, 249 completed the posttest. The total attrition rate across the entire sample was 15.02%. There was no differential attrition between the intervention condition (14.6%) and the control condition (15.9%, $p = .86$). Pre-test and post-test surveys were linked using student ID codes. A preregistered attention check question was included in both the pre-test and post-test to assess whether students were carefully reading survey questions. Within the subset of students that completed both surveys, 21 students failed only the pretest attention check, 18 students failed only the posttest attention check, and 17 students failed both attention checks. These 52 students were excluded from analyses, though we confirmed that the statistical significance of all tests reported below were unchanged when these students were included. The final sample therefore included 197 students, with 134 students assigned to the intervention condition and 63 students assigned to the *school-as-usual* condition.

The final sample consisted of 195 freshmen, one junior, and one senior. Ages ranged from 14 to 17, with a mean of 14.5. Ninety-four students identified as male, 96 identified as female, two identified as nonbinary, and five preferred not to say. Approximately 21% of the sample (42 students) identified as Hispanic. The number of students identifying with a specific race was as follows: Asian—74; Caucasian—57; no response—41; mix of two or more races—24; American Indian/Alaskan Native—1. Individual socioeconomic data were not gathered from students; however, we collected publicly available data on the percentage of students receiving free or reduced lunch at each school (School 1 in Santa Barbara, CA: 41%; School 2 in Carpinteria, CA: 54%; School 3 in Redmond, WA: 2%).

### Procedure

All students completed anonymous 15-min online surveys at pre-test and post-test. Students were informed about which condition they were in after the pretest. Although Finding Focus was designed for administration within school classrooms, students had to complete the course at home using their own devices due to the COVID-19 pandemic. Nonetheless, no other modifications were made to the protocol, given that the intervention and surveys were originally designed to occur entirely online. Teachers invited students to participate in the surveys, distributed and collected consent forms, and provided access codes to the surveys. Over the following weeks, teachers carved out time for students to complete Finding Focus during online class time.

The Finding Focus intervention was delivered through a custom digital learning platform that allowed students to access the course on computers, tablets, or phones. The entire course included 2.5 hr of content, including four 12-min lessons and daily 4-min exercises. Content unlocked over 22 days, with one lesson unlocking each week and an exercise unlocking each day. Teachers were encouraged to have students complete the lessons and daily exercises during class.

The course provided students with repeated practice in the skills of (a) focusing on one specific aspect of their experience while (b) inhibiting the tendency to become distracted by other thoughts and perceptions. It also provided students with detailed guidance on how to use these skills to have more influence over their thoughts, evaluations, and emotions. The course lessons presented three fundamental skills: anchoring, focusing, and releasing. Anchoring was defined as intentionally deciding where to focus. Focusing was defined as directing your attention to the anchor you chose. Releasing was defined as letting go of a distraction by not giving it any more attention.

These three fundamental skills were trained through daily exercises. The course featured several kinds of daily exercises that

each involved focusing on a specific aspect of experience, such as the sensations of breathing or the sounds of music. Students were encouraged to deliberately anchor their attention on the relevant aspect of their experience, focus their attention on that experience, and release all distracting thoughts and perceptions. Students also learned how to use these three skills in daily life by applying specific strategies such as refocusing (releasing a counterproductive thought and choosing a more worthwhile anchor) and reevaluating (releasing an unhelpful evaluation and focusing on a more empowering one).

The entire intervention was delivered using a custom digital learning platform that provided content tailored to the needs and interests of individual students. For example, students indicated their preferred music genre and then received daily exercises in that genre. Each student completed the intervention independently but simultaneously with their classmates. The digital learning platform provided teachers with an interface to track student progress throughout the course.

Following the 22-day intervention, teachers administered the link to the posttest survey to students across both conditions. All participants were encouraged to complete the posttest regardless of their intervention adherence. Just as with the pretest survey, students completed the online posttest survey at home independently.

## Measures

Validated self-report instruments were used whenever possible. In cases where no validated instrument existed to address the specific research question of interest, researcher-developed measures were used. All measures were written to maximize face validity using vocabulary appropriate for adolescents. Unless otherwise indicated, instruments were included at both pre-test and post-test across both conditions. The order of instruments was randomized.

### *FOI*

FOI measures the degree to which an intervention was delivered as intended. FOI was evaluated in two ways: (a) *dosage*: the percentage of lessons and exercises that students completed, and (b) *quality of facilitation*: the extent to which teachers introduced the intervention positively and set clear expectations for completing the lessons and daily exercises. Dosage for the lessons and daily exercises was recorded objectively by the digital learning platform. Completion averages were calculated across classrooms for each teacher. Quality of teacher facilitation was rated by students through three questions in the posttest. The first item asked, "When you first began this course, how much did your teacher seem to value it?" (1 = not at all; 2 = some; 3 = quite a bit; 4 = a lot). The second item asked, "Did your teacher set the clear expectation that you should complete all four lessons?" (yes; kind of; no). The third item asked, "Did your teacher set the clear expectation that you should complete all daily beats?" (yes; kind of; no). Students were also asked at posttest "Did you have any technical difficulties signing up for the course?" with response options being "yes" and "no." Students in the control condition did not answer these questions about teacher facilitation.

### *Life Demands*

The primary outcome measures of this study, including mindsets about attention, mind-wandering in daily life and academic activities, classroom focus, and emotion regulation, may be influenced by how overwhelmed one feels. Previous work has shown that how overwhelmed one feels, as measured by overall life demands, can vary depending on the time of the semester (Job, Walton, et al., 2015). Accordingly, an adaptation of Job, Bernecker, et al. (2015) one-item measure of life demands was included to assess the possibility that changes in outcomes from pre-test to post-test could be driven by confounding changes in life demands. This measure asked, "Over the last 7 days, how much have you had on your plate to deal with (e.g., homework, exams, managing relationships, extracurricular commitments, health challenges, etc.)?" on a scale from 1 (*way less than usual*) to 5 (*way more than usual*).

### *Mindsets About Focus*

Previous work has suggested that for an attention training program to be effective, it should consider and attempt to influence students' mindsets about attention (Mrazek et al., 2020; Mrazek, Mrazek, Reese, et al., 2019). Accordingly, beliefs about one's ability to focus were measured using The Mindsets about Focus Scale (Mrazek et al., 2020; Mrazek, Mrazek, Reese, et al., 2019). We included the *growth mindset subscale* to evaluate whether students believe their focus can improve through training ("My ability to focus is a skill that can get much better with practice") and the *self-efficacy subscale* to evaluate how confident they are in their abilities to improve their attention ("I know exactly what to do to increase my ability to focus"). Both subscales had sufficient internal reliability at pretest (growth mindset: $a = 0.80$; self-efficacy: $a = 0.81$).

### *Mind-Wandering in Daily Life*

The Mind-Wandering Questionnaire measures trait levels of mind wandering ("I find myself listening with one ear, thinking about something else at the same time"). This five-item questionnaire showed sufficient reliability at pretest ($a = 0.82$), and it has been validated with both adults and adolescents (Mrazek et al., 2013).

### *Mind-Wandering During Academic Activities*

Two questions drawn from Mrazek et al. (2020) were used to assess students' tendencies to mind-wander during academic activities: (a) "While I'm in class, I mind-wander or daydream about things unrelated to class," and (b) "While I'm doing homework, I mind-wander or daydream about things unrelated to my homework." For both questions, students responded on a 4-point scale (1 = rarely, 2 = sometimes, 3 = often, 4 = very often). Following prior research, each question was treated as a discrete measure.

### *Classroom Focus*

Following Mrazek et al. (2020), students were asked, "On average across all your classes, how often do you keep your undivided attention focused on class?" A second question then stated:

> This next question is NOT about what other people think you should do. It's about what you believe is best for yourself. On average across all your classes, how often would you ideally keep your undivided attention focused on class?

Both questions were asked on a scale from 0% to 100% of the time.

**Table 1**
*Means, Standard Deviations, and ANCOVA Results for Pre/Post Instruments*

| | Intervention | | | Control | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pretest | Posttest | Paired *t* test | Pretest | Posttest | Paired *t* test | ANCOVA | | |
| Measure | *M* (*SD*) | *M* (*SD*) | *p* | *M* (*SD*) | *M* (*SD*) | *p* | *F* | *p* | *d* |
| Mind-wandering in daily life (1–6 scale) | 3.51 (1.05) | 3.38 (1.02) | .09 | 3.55 (0.96) | 3.79 (1.06) | 0.03 | 11.48 | <.001 | 0.52 |
| Growth mindset (1–6 scale) | 4.85 (0.78) | 5.04 (0.86) | .01 | 4.90 (0.68) | 4.87 (0.66) | 0.73 | 7.50 | <.001 | 0.42 |
| Self-efficacy (1–6 scale) | 3.96 (1.04) | 4.74 (0.98) | <.001 | 4.09 (1.00) | 4.06 (0.91) | 0.78 | 33.57 | <.001 | 0.89 |
| Emotion regulation (1–6 scale) | 4.07 (0.88) | 4.38 (0.95) | <.001 | 3.91 (0.96) | 4.00 (1.02) | 0.44 | 5.94 | .02 | 0.37 |
| Mind-wandering during class (1–4 scale) | 2.37 (0.94) | 2.31 (0.89 | .40 | 2.56 (0.88) | 2.60 (0.83) | 0.62 | 4.04 | .05 | 0.31 |
| Mind-wandering during homework (1–4 scale) | 2.43 (1.03) | 2.38 (0.98) | .56 | 2.65 (0.88) | 2.57 (0.89) | 0.53 | 0.46 | .50 | 0.10 |
| Actual focus (0–100 scale) | 67.46 (19.28) | 69.92 (20.35) | .07 | 65.08 (20.08) | 64.06 (21.12) | 0.62 | 3.60 | .06 | 0.29 |
| Ideal focus (0–100 scale) | 80.63 (20.24) | 81.18 (20.21) | .73 | 82.87 (18.40) | 83.38 (18.55) | 0.79 | <0.001 | .97 | 0.00 |
| Life demands (1–5 scale) | 3.59 (1.06) | 3.49 (1.18) | .39 | 3.81 (0.97) | 3.51 (1.06) | 0.06 | <0.001 | .98 | 0.00 |

*Note.* ANCOVA = analysis of covariance. All measures were self-reported by students. All ANCOVA models included school and condition as fixed factors and the pretest value as a covariate. *F* and *p* values are reported for the effect of condition on the posttest measure.

### *Emotion Regulation*

The Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA) is a version of the Emotion Regulation Questionnaire (ERQ) that is adapted for ages 10–18 (Gross & John, 2003; Gullone & Taffe, 2012). Given ambiguity regarding the appropriateness of expressive suppression as a healthy strategy for emotion regulation, only the cognitive reappraisal subscale was included ("I control my feelings about things by changing the way I think about them"). Responses were provided on a scale from 1 (*strongly disagree*) to 6 (*strongly agree*). This six-item subscale showed sufficient reliability at pre-test ($a = 0.84$).

### *Self-Reported Benefit*

At posttest, students were asked to indicate whether they felt the intervention personally benefitted them (yes/no). Students in the control condition did not answer this question.

## Data Availability Statement

The research design, hypotheses, and analysis plan were uploaded to Open Science Foundation prior to data collection. Following data collection, the data and syntax files were also uploaded (https://osf.io/rfq2v/).

## Results

The primary analyses used univariate analysis of covariance (ANCOVA) models to predict each posttest variable while modeling condition and school as fixed-factors, as well as the appropriate pretest variable as a covariate. Although conceptually schools might be best thought of as random rather than fixed, it is not possible to treat them as random given that there were only three schools (Maas & Hox, 2005). Therefore, including school as a fixed effect was the appropriate approach to control for any confounding influences of school. In practice, this also accounted for any confounding influence of teacher, because only one teacher participated from each school.[1] Any deviations from this analytic approach are described below. ANCOVA results, paired sample *t* tests within condition, and raw descriptive statistics are reported in Table 1. Effect sizes are included for all ANCOVA results. We calculated Cohen's *d* effect sizes using the: (a) sample size of the treatment group, (b) sample size of the control group, and (c) *F* statistic from that test (Cohen, 1992; Thalheimer & Cook, 2002). Because this approach uses the *F* statistic from the ANCOVA, it accounts for the effect of the baseline covariate as well as the fixed effect of school. Adjusted means and standard errors for each measure are reported in Table 2.

## Equivalence of Conditions at Pretest

A series of one-way ANCOVAs indicated that there were no pretest differences between conditions for any measure (all *p*s > .14).

## FOI

According to survey data at posttest, 94.7% of students reported that they had no technical difficulties signing up for Finding Focus. Intervention dosage data were collected objectively from the digital learning platform. On average, students completed 92% of lessons and 90% of the daily exercises. Table 3 presents dosage rates by school.

Most students (92.5%) reported that their teacher sets a clear expectation that they should complete all the lessons. Similarly, 90.2% of students said their teacher set a clear expectation to complete all the daily exercises. Students also reported how much their teacher seemed to value Finding Focus when they first began completing it ($M = 3.51$, $SD = 0.60$). No students said "none"; 5.3% said "some"; 28.3% said "quite a bit"; and 56.4% said "a lot."

## Life Demands

Across the entire sample, there was a reduction in perceived life demands from pretest ($M = 3.66$, $SD = 1.04$) to post-test, $M = 3.50$, $SD = 0.08$; $t(197) = 1.79$, $p = .07$. However, there was no

[1] Analyses do not account for potential confounding influences of classroom. Classroom membership was not available in the student-level data, which was collected through the pre-test and post-test surveys.

**Table 2**
*Estimated Marginal Means at Posttest*

| Measure | Intervention *M* (*SE*) | Control *M* (*SE*) |
|---|---|---|
| Mind-wandering in daily life (1–6 scale) | 3.44 (.07) | 3.86 (.11) |
| Growth mindset (1–6 scale) | 4.99 (.06) | 4.71 (.09) |
| Self-efficacy (1–6 scale) | 4.66 (.08) | 3.87 (.12) |
| Emotion regulation (1–6 scale) | 4.31 (.07) | 4.00 (.11) |
| Mind-wandering during class (1–4 scale) | 2.37 (.06) | 2.59 (.10) |
| Mind-wandering during HW (1–4 scale) | 2.47 (.07) | 2.55 (.11) |
| Actual focus (0–100 scale) | 69.35 (1.37) | 64.90 (2.06) |
| Ideal focus (0–100 scale) | 80.19 (1.39) | 80.10 (2.09) |
| Life demands (1–5 scale) | 3.55 (.10) | 3.56 (.15) |

*Note.* *SE* = standard error; HW = homework. Table 2 displays the estimated marginal means and standard errors at posttest accounting for covariates (e.g., school and baseline value).

difference between conditions in change in perceived life demands, $F(4, 192) = 0.001$, $d = .00$.

## Mindsets About Focus

Compared to students in the control group, students in the intervention group were more likely to report adopting a growth mindset regarding their ability to focus at posttest, $F(4, 192) = 7.50$, $d = 0.42$, and they also reported being more confident that they knew how to improve their ability to focus, $F(4, 192) = 33.57$, $d = 0.89$; Table 1.

## Mind-Wandering

Relative to students in the control condition, students in the intervention group reported less mind-wandering at posttest during everyday activities, $F(4, 192) = 11.48$, $d = 0.52$, and during class, $F(4, 192) = 4.04$, $d = 0.31$, but not during homework, $F(4, 192) = 0.46$, $d = 0.10$; Table 1. Reductions in self-reported mind-wandering during class and homework correlated with reductions in mind-wandering during daily life ($r = 0.32$, $p < .001$ and $r = 0.23$, $p < .001$, respectively).

## Classroom Focus

At pretest, students felt they should ideally keep their undivided attention focused on class 81.35% of the time ($SD = 19.65$). They reported actually keeping their attention focused on class 66.7% of the time ($SD = 19.52$). Seventy-seven percent of students at pretest reported focusing less often during class than they felt they ideally should.

**Table 3**
*Intervention Dosage Objectively Collected by the Digital Learning Platform*

| School location | No. of classes | No. of students | Lesson completion | Exercise completion |
|---|---|---|---|---|
| Santa Barbara, California | 2 | 67 | 93% | 94% |
| Carpinteria, California | 2 | 55 | 90% | 90% |
| Redmond, Washington | 3 | 92 | 93% | 86% |

*Note.* Dosage data include all classes that received the intervention at each school. Schools are listed by descending levels of dosage.

At posttest, there was no difference between conditions in how much students felt they should focus during class, $F(4, 192) < .001$, $d = 0.00$, but there was a difference in self-reported classroom focus, $F(4, 192) = 3.60$, $d = 0.29$; Table 1. Increases in perceived classroom focus were associated with reductions in perceived mind-wandering during daily life ($r = -0.17$, $p = .02$) and during class ($r = -0.21$, $p = .004$).

Previous research has suggested that the students most likely to increase their focus during class are the ones who report a discrepancy at pretest between how much they actually pay attention relative to how much they ideally should pay attention. However, there was no interaction between discrepancy at pretest and condition on actual levels of focus at posttest, $F(5, 197) = 0.06$, $p = .80$.

## Emotion Regulation

Relative to the control group, students who completed the intervention reported higher emotional regulation at posttest, $F(4, 192) = 5.94$, $d = 0.37$; Table 1.

## Self-Reported Benefit

At posttest, 82.1% of students reported that Finding Focus helped them.

# Discussion

Although there is growing evidence that attention training can improve the focus and emotional resilience of adolescents, less is known about the effectiveness of attention training that is provided digitally in high schools. The current investigation extends prior work by more rigorously demonstrating that digital attention training is feasible in high school settings and may be capable of leading to measurable improvements in a variety of valued outcomes compared to school-as-usual. Specifically, the intervention influenced students' self-reported mindsets about attention, leading them to (a) adopt a growth mindset regarding their ability to focus, and (b) have greater confidence that they know how to train that ability. The intervention also elicited reductions in self-reported mind-wandering during class and daily life, as well as improvement in self-reported classroom focus. Finally, the intervention led to improved self-reported emotional regulation.

Like many educational interventions, Finding Focus was designed to be facilitated by a teacher in a classroom setting. This classroom context was originally chosen on the presumed basis that it would support student accountability and FOI, thereby leading to greater student benefit. However, given the COVID-19 pandemic, all students were engaged in distance-learning at the time of this study. Fortunately, the digital nature of Finding Focus allowed it to still be administered, and dosage rates were high. Students completed 92% of lessons and 90% of the daily exercises. The magnitude of improvements was also similar to previous assessments of Finding Focus when it was implemented in-person. For example, the effect size for the change in emotion regulation from pre-test to post-test was $d = .29$ and $d = .44$ in two prior studies, and in the present study it was $d = .37$. Given the consensus that remote learning has led to serious learning gaps during the pandemic, it is notable that

this intervention has led to comparable benefits whether delivered in-person or through distance learning. With looming uncertainty regarding the COVID-19 pandemic's trajectory and the growing trend toward digital learning, educators may want to contemplate how to design interventions that work well in both in-person and distance-learning contexts.

## Limitations

While the present research provides a promising report on the feasibility, FOI and efficacy of digital attention training, it nevertheless has notable limitations. First, the *school-as-usual* control condition makes it impossible to rule out expectation effects as a source of the observed improvements in focus and emotional regulation. While future research should address this limitation with an active control condition that is well-matched for expectation of improvement, it is also worth noting that expectation of improvement is a critical element in many interventions, and effects derived from expectation can still represent genuine improvements (Miller & Kaptchuk, 2008).

The *school-as-usual* control condition in combination with a reliance on self-report measures also makes it impossible to rule out alternative explanations based on demand characteristics. However, it is notable that students only reported reductions in mind-wandering during class and not during homework—a pattern of findings that would not be expected if participants were merely providing answers they felt had to conform to experimenters' hypotheses. Future research should circumvent this limitation by examining the efficacy of digital attention training programs with an emphasis on including objective based metrics of improved academic focus such as grade point average (GPA), standardized test scores, and reading comprehension measures.

Additionally, the generalizability of these findings is unclear. In this sample, 21% of students identified as Hispanic, 38% identified as Asian, 12% identified as mixed race, and 0% identified as Black. The sample consisted of similar levels of male and female students, as well as two students identifying as nonbinary. Socioeconomic data were not collected. All students attended public high schools on the west coast of the United States. Although these findings may generalize to broader samples of high school students, future research utilizing representative samples is needed to confirm this.

Finally, it is also important to note that the observed improvements were statistically significant between conditions at posttest, but there were not always statistically significant changes within the intervention group from pre-test to post-test. In some cases, the significant difference between conditions was driven by nonsignificant changes within conditions that were in opposite directions for the treatment group versus the control group. This pattern of findings is not unusual for intervention research, and it is often interpreted as the intervention preventing a negative change that occurred within the control group (Jha et al., 2010). Nevertheless, this pattern of findings should be interpreted as less definitive.

## Future Directions

The present research points to several areas for future research. One topic deserving of further investigation is the potentially synergistic relationship between reducing mind-wandering and improving emotion regulation. As demonstrated in the present research, an intervention designed to improve attentional control can impact both mind-wandering and emotion-regulation. However, these two outcomes may also be reciprocally beneficial. Previous research indicates that negative affect can lead to more frequent mind-wandering (Smallwood et al., 2009). Meanwhile, more frequent mind-wandering can also lead to more negative affect (Killingsworth & Gilbert, 2010). Future research could examine the longitudinal relationship between these two interrelated phenomena.

Building off this direction for future work, it would also be informative to examine whether the adoption of a domain-specific growth mindset could impact mindsets about other domains as well. As shown in the present research, a growth mindset about one's ability to focus can increase with effective training. Given the relationship between attentional control and emotion regulation, perhaps a growth mindset about attention may also spur the adoption of a growth mindset about emotional regulation. Previous work conducted with adolescents suggests that students can hold a growth mindset in one area (e.g., intelligence) and a fixed mindset in another area (e.g., relationships; Chan et al., 2022). However, there may be a domino effect of developing a growth mindset in one domain on the mindsets held for other closely related domains.

Another area for future work is assessing the near versus far transfer effects of attention training among adolescents. Transfer effects refer to how closely the domain of the intervention training is related to the domain of the assessed performance (Barnett & Ceci, 2002). Near transfer refers to performance in a similar domain as the intervention, whereas far transfer refers to performance in a different domain. However, "near" and "far" are subjective terms. For example, in the present study, attention training occurred during 21, 4-min daily exercises. These exercises were completed individually with headphones while using an app. Students closed their eyes, focused their attention on a song or guided meditation, and practiced releasing distractions. One may argue that near transfer would be students staying focused during a novel 4-min exercise on the app, while far transfer would be students staying focused while listening to a recorded lecture. Alternatively, one may argue that near transfer would be students staying focused while listening to a recorded lecture, while far transfer would be improved focus while reading. By designating the study's transfer goals a priori, researchers will better characterize the assessed outcomes in relation to the training provided.

Finally, an important direction for future research is to determine whether scalable digital interventions could help prevent mental illness among high school students. Mental health issues among teens have been increasing over the last decade with an alarmingly sharp spike during the pandemic. In 2021, a nationwide Centers for Disease Control and Prevention (CDC) survey of high school students found that 44% reported persistent feelings of sadness or hopelessness that prevented them from participating in normal activities, and 9% reported attempting suicide (Centers for Disease Control & Prevention, 2022). Most solutions to this mental health crisis are currently focused on clinical treatment rather than skill-based prevention. However, with mental health issues becoming this prevalent, a prevention-focused approach is crucially important. The present work suggests it is possible to empower teens with emotion regulation skills via a digital curriculum, and future work should assess whether this could be extended to prevent mental illness among teens.

## Conclusion

Despite having important limitations, the present findings still provide an encouraging report on the role that digital attention training interventions might play in the future of education. Adolescents are growing up in what is arguably the most distracting time in history amid increasing rates of stress, emotional distress, and mental illness (Collishaw, 2015; Gunnell et al., 2018). Research indicates that attention training can be a useful tool for addressing these challenges (Zenner et al., 2014), but it is far from trivial to deliver effective attention training to the millions of adolescents who might benefit from it. Future research should therefore continue to explore whether digital attention training interventions can be a promising path to improving the focus and emotional well-being of students at scale.

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