



Theory-driven design and validation of a tool to enhance academic focus

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Abstract

Drawing on 11 evidence-based design principles, we developed a digital tool for training attention during academic activities. Two naturalistic, single-group pre-post studies—including a pre-registered direct replication—evaluated the impact of this tool on the attentional focus of adolescents across multiple public schools (Study 1: N = 322; Study 2: N = 695). Students used the tool during independent work, and focus was assessed through real-time check-ins during tool use as well as pre- and post-intervention surveys. Students' real-time focus improved within individual sessions and cumulatively across multiple sessions, with sensitivity analyses revealing that improvements emerged early and continued over time. Across-session gains extended to students with attention-deficit/hyperactivity disorder, though within-session gains did not. Students also reported improved overall focus during class and independent assignments, with the largest gains among students who completed the most sessions. These findings demonstrate the viability of a scalable, curriculum-agnostic approach to training attention in schools and underscore the value of theory-driven intervention design.

Keywords Instructional design · Focus · Attention · Technology-enhanced learning · Self-regulated learning

Distraction is one of the most pressing challenges in education, with public school leaders identifying inattention as the most prevalent barrier to both learning and teacher morale (National Center for Education Statistics, 2024). Increasing external distractions from

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devices have combined with longstanding internal distractions like mind-wandering to create classrooms characterized by disengagement and reduced learning (Beland & Murphy, 2016; Chen et al., 2025; Smallwood & Schooler, 2006; Szpunar et al., 2013). Even when students attempt to focus on an important task for just 15 minutes, they spend more than a third of that time distracted (Rosen et al., 2013).

The ability to focus, however, is a skill that can be strengthened through structured support and deliberate practice (Mrazek et al., 2020a; Mrazek et al., b; Jong et al., 2025; Posner et al., 2015; Sumantry & Stewart, 2021). Moreover, most students recognize they should be more attentive in class and are open to strategies that help them sustain focus (Mrazek et al., 2019b, 2020a, 2021, 2022). This presents a valuable opportunity to design interventions that not only help students concentrate in the moment but also build their capacity for sustained attention over time. Drawing from research in educational psychology and cognitive science, we identified 11 scientific insights and design strategies to guide the development of an intervention to promote academic focus. We then evaluated this novel intervention in two pre-registered studies to determine whether it would improve students' self-reported focus during academic work.

Design principles

Effective interventions are rarely built from a single insight; they succeed by combining multiple, mutually reinforcing design choices. Drawing on research in educational psychology and cognitive science, we identified 11 scientific insights and corresponding design strategies that together specify what an intervention could do to promote academic focus. We describe each principle in turn, along with the evidence supporting it and its implications for design. Then, we draw on these principles to guide the design of a novel intervention to train students' attention.

Principle 1: seamless integration into diverse classrooms

To maximize impact, interventions should seamlessly integrate into existing classroom routines while remaining flexible enough for broad use. Public school districts prioritize approaches that minimize teacher burden and fit within existing instructional practices because this makes interventions more sustainable (Durlak & DuPre, 2008; Penuel et al., 2007). Designing interventions to be used during academic tasks ensures students can engage with them regularly without disrupting learning. At the same time, broad applicability across grade levels and subject areas allows interventions to be used frequently over multiple years, reinforcing skill development over time.

Principle 2: reduced need for transfer effects

A common critique of cognitive training interventions is that improvements often fail to transfer to real-world contexts (Sala & Gobet, 2017). This limitation arises because many interventions develop skills in ways that are disconnected from their practical applications, such as computer-based tasks that bear little resemblance to the contexts in which the skills are needed (Lintern & Boot, 2021; Stojanoski et al., 2021). To enhance real-world applicability, educational interventions could embed skill development directly within the relevant academic context. By integrating attention training into students' existing academic work,

an intervention minimizes the need for transfer, ensuring that improvements in focus occur where they are most needed.

Principle 3: framing effects for increased motivation and skill building

Students engage more deeply in tasks when they see them as opportunities to develop valuable skills rather than as mere requirements (Dweck, 2006; Schunk & Zimmerman, 1997). An intervention could leverage this insight by framing schoolwork as an opportunity to train attention, positioning assignments as a pathway to improving a widely applicable skill. This framing assumes that students value attention as a skill worth developing, and prior research supports that assumption: most students report focusing less than they believe they ideally should and express interest in strategies that help them increase their focus (Mrazek et al., 2019b, 2020a, 2022). Students who see assignments as an opportunity to train attention may therefore be more likely to invest effort and sustain focus in the moment. Beyond enhancing momentary engagement, this framing could also encourage students to treat assignments as deliberate practice in attentional control, fostering the intentional engagement that best supports skill acquisition (Ericsson et al., 1993; Schunk & Zimmerman, 1997).

Principle 4: strong attentional sets

Without an intentional transition into focused work, students are more vulnerable to distraction. Research suggests that deliberately establishing a strong attentional set—a mental framework that directs cognitive resources toward goal-relevant information while filtering out distractions—can improve sustained attention and task performance (Corbetta & Shulman, 2002; Desimone & Duncan, 1995). One way an intervention could strengthen an attentional set is through pre-task planning, where students could choose a goal for how long they will stay focused (Esterman & Rothlein, 2019; Monsell, 2003). Additionally, a brief pre-task routine, such as taking a deep breath while mentally committing to a task, could help reinforce a shift into focused work.

Principle 5: self-monitoring of attention

Self-monitoring is a key aspect of self-regulation, enabling individuals to observe and evaluate their own behavior relative to a goal (Carver & Scheier, 1982; Zimmerman, 2002). By increasing metacognitive awareness, self-monitoring helps individuals recognize discrepancies between their intended and actual performance. An intervention could promote self-monitoring through intermittent check-ins that prompt students to periodically assess their focus. These periodic check-ins could make students more likely to notice and correct lapses of attention. Over time, this practice could strengthen students' ability to regulate their attention independently.

Principle 6: external accountability

Individuals are more likely to sustain effort when they know their engagement is being tracked, even in the absence of evaluation or enforcement (Matus et al., 2024; Vohs & Baumeister, 2016). Check-ins that prompt students to report whether they are focused or

distracted could foster this accountability. Knowing that check-ins will occur—and that their engagement is being tracked over time—could create a continuous sense of accountability, encouraging students to sustain their focus. While individual responses would need to remain private to encourage honest reporting, an intervention could provide teachers with information about which students complete check-ins and the overall focus trends within a class, adding an additional layer of interpersonal accountability.

Principle 7: reinforcing attention through positive feedback

Students are more motivated to sustain effort toward their goals when they receive positive reinforcement along the way. Research on goal setting highlights the benefits of progress goals, which emphasize celebrating small achievements (Locke & Latham, 2002). Immediate, positive reinforcement has also been shown to strengthen goal-directed behavior (Cameron et al., 2001; Hattie & Timperley, 2007). Building on this literature, an intervention could integrate periodic check-ins that not only promote self-monitoring and external accountability but also provide reinforcing feedback. When students are focused at the time of a check-in, the simple act of confirming their focus could serve as a small but meaningful reward that sustains attention.

Principle 8: distraction recovery

Once distracted, students may remain off task for extended periods unless they are prompted to refocus. Research on mind-wandering and cognitive control suggests that external cues can help individuals detect attentional lapses more quickly and reorient to the task at hand (Esterman et al., 2013; Schooler et al., 2011; Smallwood & Schooler, 2006). Unlike preventative strategies, distraction recovery mechanisms acknowledge that lapses are inevitable. Instead of trying to prevent every distraction, distraction recovery strategies aim to minimize time spent disengaged. The same check-ins that support self-monitoring and external accountability could also prompt students to recognize when their attention has drifted and help them quickly refocus on their work.

Principle 9: environmental constraints on distraction

Reducing access to distractions can enhance focus by limiting the cognitive burden of self-control. Research on self-regulation suggests that modifying one's environment to minimize temptations is often more effective than relying on willpower alone (Duckworth et al., 2016; Ward et al., 2017). While working on a school assignment, especially during homework, phones are a particularly pervasive source of distraction. However, a recent evaluation of school phone policies across 30 secondary schools found that restrictive policies were not associated with lower overall phone use or better student outcomes (Goodyear et al., 2025). The fact that restrictive phone policies can fail to limit phone use may in part be explained by students' desire to keep their phone close by (Diefenbach & Borrmann, 2019; Mrazek et al., 2021). An intervention could mitigate this challenge by displaying on a student's phone screen while preventing them from switching to unrelated apps.

Principle 10: structuring an optimal auditory environment for focus

Background audio can support focus in three key ways: by masking distracting noise, enhancing enjoyment, and regulating arousal levels (Kiss & Linnell, 2021; Kiss et al., 2024; Loewen & Suedfeld, 1992; Schellenberg, 2005). Enjoyable background audio can boost mood and increase intrinsic motivation, making tasks feel more engaging and improving persistence on cognitively demanding work (Lesiuk, 2005). Additionally, low-arousal instrumental music can help regulate arousal by providing a calming effect that reduces stress and minimizes mental fatigue, keeping students in an optimal state for sustained cognitive engagement (Schellenberg, 2005; van der Zwaag et al., 2012). However, many students select music with lyrics or high variability, which can impair cognitive performance (Ghojzadeh et al., 2023; Kämpfe et al., 2011). Additionally, frequently switching songs may increase task-irrelevant cognitive load, further disrupting focus. An intervention could optimize students' auditory environment by providing curated, looping ambient soundtracks that minimize distractions while enhancing enjoyment and promoting a state of relaxed focus.

Principle 11: shaping classroom culture and shared norms

Research on social learning suggests that individuals are more likely to persist in self-regulatory tasks when they see their peers participating in the same process (Bandura, 1986; Rogoff, 1990). Embedding attention training into the classroom culture could help normalize it as a shared practice rather than an individual struggle. An intervention could promote this shift by making attention training a visible, classroom-wide effort through shared experiences in which all students actively work to train their attention.

Objective of the present studies

Although each of the 11 principles is individually supported by prior research, no existing attention-training intervention integrates them into a single tool. This is the gap the present research addresses, and it responds to recent calls to move beyond restrictive strategies such as device bans toward interventions that address the root causes of distraction, particularly in under-researched K-12 settings (Martin et al., 2025). Our objective was to design a tool guided by these principles—one that embeds attention training directly within students' everyday academic work—and to evaluate whether it improves students' focus. Across two studies, including a pre-registered direct replication, we examined whether students demonstrate attentional improvements while using the tool, whether their focus improves cumulatively with continued use, and whether benefits extend to their broader academic experiences.

Designing the Focus Coach

We developed the Focus Coach as a no-cost, publicly available study tool designed to strengthen students' ability to regulate their attention during academic work. The Focus Coach was designed to complement a brief online course that introduces students to foundational attention-training skills: choosing an anchor for their attention, focusing on it, and

releasing distractions (Mrazek et al., 2019a). Previous research has shown that the course improves students' self-reported classroom focus and emotional regulation (Mrazek et al., 2019b, 2020a, 2022) as well as their mental health (Mrazek et al., 2024). Whereas the course introduces these attentional skills, the Focus Coach provides structured opportunities to practice them during real academic work, embedding attention training into students' daily routines.

The Focus Coach was developed over two years through an iterative, multi-stage process. We first tested the initial concept in college classrooms to assess its basic feasibility, then conducted extensive focus groups to gather feedback on the tool's design and approach. This input informed a minimum viable product that underwent usability testing, after which we deployed a more fully developed version in several high school classes across two rounds of implementation, collecting feedback from students and teachers at each round and refining the tool in response. Throughout, the design was guided by the 11 principles described above, with the goal of integrating attention training into students' daily learning routines.

The Focus Coach supports students during structured work sessions. To help students establish an attentional set, the tool prompts them to determine how long they intend to work and how frequently they want to check in on their attention. As a brief pre-task routine, students are then guided to take a deep breath to deliberately transition into focused work. Throughout the session, intermittent check-ins prompt students to self-monitor their attention, fostering metacognitive awareness and creating a sense of accountability to the tool itself. While individual responses remain private, teachers can view overall engagement patterns, reinforcing interpersonal accountability.

When students are focused, check-ins serve as a rewarding opportunity to confirm their attention was on task. When students become distracted, check-ins serve as a reminder to refocus. To further limit external distractions, the tool remains visible on students' laptop screens and occupies the entire screen on phones, preventing easy access to unrelated apps. Additionally, it provides access to a selection of ambient soundtracks, allowing students who prefer background audio to choose from curated options that minimize disruption rather than introduce additional distractions.

The tool is designed to be used frequently across subjects and grade levels, including during independent work or homework. Students can complete sessions independently or a class can complete a session together, with the timer and check-ins synchronized across students' devices. By embedding attention training into classroom routines, it encourages more frequent use, reduces the need for skill development to transfer from an artificial training context, and reinforces a shared culture of focus as students engage in the practice together. The two tools, the course and the Focus Coach, can be delivered together or separately. In the following studies, they were delivered together through a single digital learning platform.

Study 1

This study evaluated the novel study tool delivered alongside the online attention-training course. Using a naturalistic implementation across multiple schools, we examined whether students demonstrated attentional improvements during tool use and whether benefits transferred to broader academic experiences and emotional regulation.

Study 1: method

Design

A single-group, pre-post design assessed within-subject changes in focus during a six-week period during the spring semester.

Participants

Five high school teachers participated, each from a different public school in California, Michigan, or Washington. A total of 322 students completed the pre-test, and 344 completed the post-test. Real-time check-in data were available for 293 students. Each analysis used the maximum available data.

Demographics are reported for the sample of students ($n = 305$, 48% female) who completed both the pre-test and post-test, as most analyses were conducted using this matched dataset. This sample included 274 (90%) freshmen, 12 sophomores (4%), 8 juniors (3%), and 11 seniors (4%). Ages ranged from 13 to 18 ($M = 14.75$, $SD = 0.82$). Racial/ethnic identification: White/Caucasian—97 (32%); Hispanic/Latino—138 (45%); Black/African American—11 (4%); Asian—23 (8%); Multiracial—27 (9%); American Indian/Alaskan Native—2 (<1%); Native Hawaiian/Pacific Islander—1 (<1%); Other—2 (<1%); Prefer not to say—4 (1%).

Free and reduced lunch rates ranged from 17 to 83%, with a mean of 37.0% ($SD = 27.63\%$), based on publicly available school demographic data. Parental education was assessed by asking students to report the highest level of education completed by any of their parents/guardians; 21 (7%) of students reported ‘Some high school,’ 30 (10%) ‘High school graduate,’ 31 (10%) ‘Some college,’ 106 (35%) ‘College graduate,’ 34 (11%) ‘Post-graduate degree,’ and 83 (27%) indicated ‘I don’t know.’

Procedure

During the week prior to the six-week intervention period, students completed a 5-min pre-test survey, administered online via Qualtrics during class time. Teachers then enrolled students in the digital learning platform by providing them with a class invite code from their educator interface. Students typically began with the 80-min online course and subsequently used the Focus Coach during independent work at their teacher’s discretion. In most classes, the course preceded any use of the Focus Coach, though in some classes the two overlapped; no class began with the Focus Coach before starting the course. During the week following the intervention period, students completed a 5-min post-test survey containing the same measures as the pre-test. All measures administered in the surveys, along with an embedded attention check, are described below.

Intervention

The intervention consisted of two complementary components delivered through a single digital learning platform: a brief online course and the Focus Coach study tool. Both components were accessible on a computer, tablet, or phone. The course and study tool share

a common goal of strengthening students' attention, but they do so in different ways. The course teaches foundational attention skills and has students practice them within guided exercises, while the study tool has students apply those same skills during their everyday academic work. An educator interface enabled teachers to enroll students and track their engagement with both components.

The online course was designed to teach students foundational skills for regulating their attention. It introduced three key attentional skills. *Anchoring* was defined as intentionally deciding where to focus. *Focusing* referred to directing attention to the chosen anchor. *Releasing* involves letting go of distractions by not giving them any more attention. The course was primarily instructional, teaching students what these skills are and how they can be used to regulate thoughts, evaluations, and emotions, with brief guided exercises to illustrate them. Additional details on earlier versions of the course have been described in prior reports (Mrazek et al., 2022; Richelle et al., 2024).

The Focus Coach is a study tool that students keep open on their phone or computer while completing a separate assignment. It administers periodic check-ins modeled after ecological momentary assessments. Before starting a session, students customize their experience by selecting their preferred duration for the session, adjusting the frequency of check-ins, choosing a check-in sound, and selecting an optional ambient soundtrack. As students work, check-ins occur periodically, playing a brief sound and prompting students to assess their focus on a five-point scale from focused to distracted. After students select their answer, the check-in disappears without providing any explicit feedback. At the end of each session, the tool displays a graph of their focus throughout the session. An educator interface allows teachers to monitor students' real-time use of the tool, including instances of missed check-ins. Students were informed that teachers could see whether they responded to a check-in but not which answer they selected (Fig. 1).

Measures

Mindsets about focus

The Mindsets about Focus Scale (Mrazek et al., 2019b, 2020a) includes two subscales that evaluate whether students believe their focus can improve through training (e.g., *My ability*

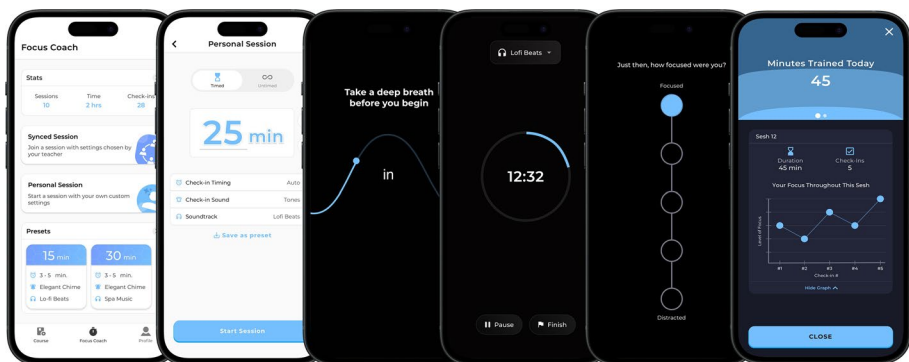


Fig. 1 Overview of the Focus Coach digital tool, which supports attention training through customizable sessions, real-time self-monitoring, and progress tracking

to focus is a skill that can get much better with practice) and how confident they are in their abilities to improve their attention (e.g., *I know exactly what to do to increase my ability to focus*).

Real-time focus

Students' self-reported focus during independent work was measured through periodic Focus Coach check-ins asking, "*Just then, how focused were you?*" Students responded by selecting from five unlabeled options, presented between the anchor labels "focused" (above the top option) and "distracted" (below the bottom option). Responses were later coded on a 1–5 scale (1 = most distracted, 5 = most focused).

Classroom focus

Following Mrazek et al., (2020a, 2022), students were asked to report their actual focus: "*On average across all your classes, how often do you keep your undivided attention focused on class?*" A second question asked about their ideal focus: "*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 were rated from 0 to 100% of the time.

Focus during independent work

Students' focus during independent classwork was also assessed in the pre-test and post-test surveys using a single-item measure rated from 1 (strongly disagree) to 6 (strongly agree): "*When working independently in class, I am very focused.*"

Emotion regulation

The Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA) is an age-adapted version of the ERQ for individuals aged 10–18 (Gullone & Taffe, 2012). Given ambiguity about whether expressive suppression is a healthy strategy, only the cognitive reappraisal subscale was used (e.g., "*I control my feelings about things by changing the way I think about them*").

Data exclusions

A single-item attention check was embedded in both the pre-test and post-test, instructing students to select a specific answer choice. There were 29 students who failed at least one attention check, and they were excluded from analyses involving survey measures.

Before conducting analyses, Focus Coach sessions were excluded if they: (i) occurred outside of school hours or after the post-test survey, (ii) lasted less than five minutes, (iii) were paused for longer than 15 minutes, (iv) contained no answered check-ins, or (v) were abandoned mid-session. Additionally, check-ins with response times exceeding 30 seconds were excluded in Study 1, and this time limit was formally implemented in the application during Study 2. Sessions were also excluded for students whose total number of check-ins exceeded four standard deviations above the mean, as this indicated highly atypical use.

By default, incomplete data—such as sessions missing a start or end timestamp—were retained in the analyses.

Analytic approach

Sample sizes varied across analyses because each analysis used the maximum available data. Analyses of change from pre-test to post-test used students who completed both surveys after excluding students who failed an attention check. Analyses of real-time focus used all students with valid check-in data after applying the exclusion criteria described above. Analyses relating real-time focus to survey measures used students who had both valid check-in data and the relevant survey response.

Hierarchical linear modeling was used to account for three levels of clustering within the dataset. All analyses included a random intercept for *teacher* to account for the non-independence of observations due to students being nested within teachers. The teacher-level random effect was included solely to account for clustering and control for teacher-level variability, rather than to estimate or interpret teacher-level effects. Real-time focus analyses that were conducted across sessions within an individual included an additional random intercept for *student*, which accounted for stable differences between students in their overall level of focus. Models evaluating the growth in survey measures from pre-test to post-test also used a *student* random intercept to account for similarities in surveys taken by the same student. Survey data were in long-format, where every row represented a unique survey, and outcome measures were predicted by *time* (pre-test = 0, post-test = 1). Real-time focus analyses conducted across check-ins within a session included a third random intercept for *session*, which accounted for session-to-session variability in overall focus levels.

Random slopes were not included because no theoretical or empirical basis existed for hypothesizing variability in the rate of change in focus across teachers, students, or sessions. Restricted maximum likelihood was used to estimate model parameters, as it reduces bias in variance estimates for random effects in hierarchical models. Satterthwaite approximations were used to calculate degrees of freedom.

Standardized mean difference effect sizes were computed to contextualize the magnitude of growth from pre-test to post-test in terms of the naturally occurring variation in the outcome measure at baseline. As such, effect sizes were calculated by dividing the *time* regression coefficient by the pre-test standard deviation of the outcome measure. For models where the predictor of interest was continuous, making the regression coefficient a slope rather than a mean difference, no effect sizes were calculated.

Hypotheses and pre-registration

Previous research on the online course, delivered without the Focus Coach, has shown improvements in emotion regulation, growth mindset, self-efficacy, and classroom focus (Mrazek et al., 2019b, 2020a, 2022). Based on these findings, we hypothesized that these effects would replicate in the current study. Additionally, because the Focus Coach provides structured opportunities for students to train their attention during independent academic work, we proposed a novel hypothesis that students would show significant improvements in their ability to maintain focus during these sessions. Pre-registered study procedures, measures, hypotheses, anonymized data files, codebooks, and syntax files are publicly available at <https://osf.io/hvs3u> and <https://osf.io/9ctrm>.

Study 1: results

Intervention dosage

Student engagement data were objectively collected from the digital learning platform. On average, students completed 89.6% of the online course (range = 0–100%) and 6.4 Focus Coach sessions ($SD = 3.9$, range = 1–26). There was some variability in dosage across the 11 classrooms (course completion by classroom: $M = 89.5$, $SD = 3.5$, range: 84.0–98.4; completed Focus Coach sessions per student by classroom: $M = 6.6$, $SD = 2.3$, range: 3.2–9.3). Sessions averaged 20.4 minutes in active duration ($SD = 10.4$, range = 5.0–60.0). In an average session, students answered 2.6 check-ins ($SD = 1.5$) and missed 0.9 check-ins ($SD = 1.2$).

Convergent validity of check-ins

Focus Coach check-ins provide a face-valid measure of attention, consistent with research showing that students can accurately report their focus through ecological momentary assessments (Mrazek et al., 2013). Their convergent validity was supported by a positive association between real-time focus using the study tool and self-reported classroom focus as measured in the pre-test ($b = 0.008$, $SE = 0.002$, $t(241.8) = 4.46$, $p < .001$).

Mindsets about focus

From pre-test to post-test, students reported a higher growth mindset regarding their ability to focus and felt greater self-efficacy in knowing how to improve this ability (Table 1).

Real-time focus

Students reported high levels of focus while using the tool ($M = 4.5$, $SD = 0.8$, range = 1–5). Typically, focus declines with time-on-task—a well-documented effect known as the vigilance decrement (Young et al., 2009). However, while using the tool, students' real-time focus tended to increase within a session, with higher focus reported as the session progressed, $b = 0.03$, $SE = 0.006$, $t(3985) = 4.42$, $p < .001$ (Fig. 2). This suggests that when stabilizing for teacher, student, and session differences, each additional check-in increased students' reported focus by an average of .03 points on the 1–5 scale. Furthermore, their focus improved across sessions, with greater real-time focus as they completed more sessions over time, $b = 0.04$, $SE = 0.004$, $t(1702) = 9.62$, $p < .001$ (Fig. 2). This suggests that when stabilizing for random effects, each additional session increased students' reported focus by an average of .04 points on the 1–5 scale.

To assess the dynamics and robustness of improvements in real-time focus—both within individual sessions and across multiple sessions—we conducted two sets of exploratory sensitivity analyses. The first sensitivity analysis progressively removed later observations and re-tested at each step whether the effect remained statistically significant at the $p < .05$ threshold. The within-session and across-session effects both

Table 1 Means (M), standard deviations (SD), and pre-post changes in Study 1

Measure	Pre-test <i>M</i> (<i>SD</i>)	Post-test <i>M</i> (<i>SD</i>)	<i>b</i>	<i>SE</i>	<i>t</i> (<i>df</i>)	<i>p</i>	<i>SMD</i>
Growth mindset (1–6 scale)	4.8 (0.7)	5.0 (0.7)	0.22	0.04	4.99 (275.00)	<.001	0.30
Self-efficacy (1–6 scale)	3.9 (1.0)	4.5 (0.8)	0.56	0.06	9.69 (275.00)	<.001	0.58
Classroom focus for students with RTG (0–100%)	64.7 (20.5)	67.6 (20.2)	2.90	1.41	2.06 (161.00)	.04	0.14
Independent work focus (1–6 scale)	4.5 (1.0)	4.5 (1.0)	–0.03	0.06	–0.41 (268.99)	.68	0.03
Emotion regulation (1–6 scale)	4.1 (0.8)	4.3 (0.8)	0.20	0.04	4.55 (275.00)	<.001	0.24

SMD standardized mean difference effect size

Note. Students with room to grow (RTG) were those who reported lower actual focus than ideal focus at pre-test

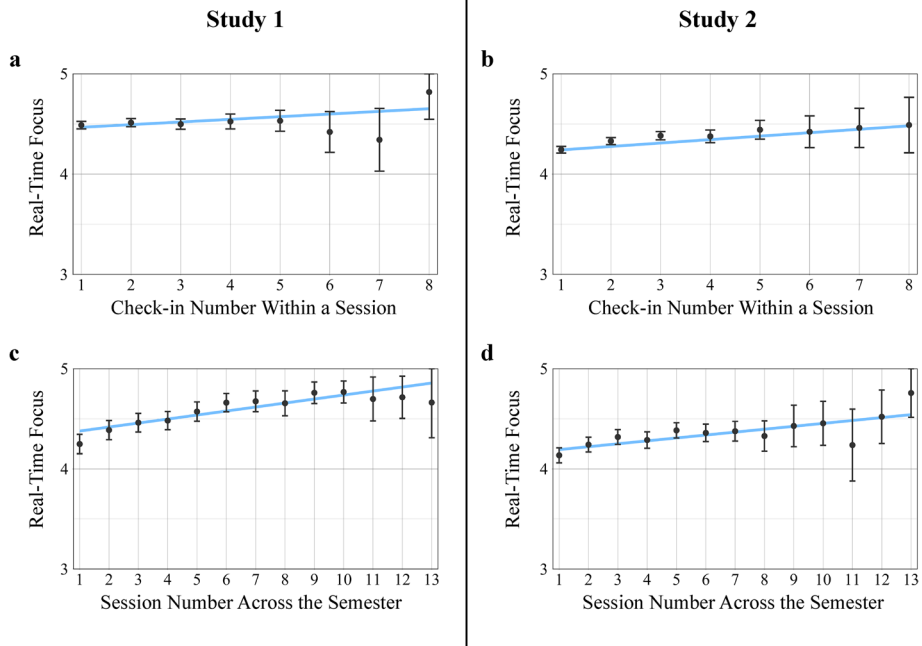


Fig. 2 Students reported real-time focus on a 1–5 scale by selecting from five unlabeled options presented between the anchor labels “focused” and “distracted”. Error bars represent 95% confidence intervals. Trend lines represent the fixed-effect slope for focus over time. For ease of visual interpretation, only time points with at least 10 observations in Study 1 are displayed

remained statistically significant at each iteration, down to analyses that included only the first three check-ins within a session or the first two sessions across the semester. These analyses reinforce the reliability of the findings and suggest that improvements in focus begin to emerge early in tool use.

We then ran sensitivity analyses that progressively removed the earliest observations. The within-session effect remained significant until the first two check-ins were excluded, consistent with the interpretation that improvements in focus predominantly emerge early within a session. However, the across-session effect remained significant until the first five sessions were excluded, indicating that focus continues to improve with ongoing use of the tool. Given that these sensitivity analyses progressively exclude more data, it is possible that null effects eventually emerge due to decreased statistical power.

Classroom focus and independent work focus

At pre-test, students felt they should ideally focus on class 76.8% of the time ($SD = 18.8$) but reported actually focusing 68.9% of the time ($SD = 19.9$). There were 58.7% of students who felt they focused less than they should. Among this a priori subset identified in prior studies (Mrazek et al., 2019b, 2020a, 2022), classroom focus increased from pre-test to post-test, $SMD = 0.14$ (Table 1). There was no significant change in independent work focus (Table 1).

Emotional regulation

From pre-test to post-test, students reported higher levels of emotional regulation via reappraisal (Table 1).

Study 1: discussion

Study 1 provided initial evidence that the Focus Coach can improve students' focus during academic work. Students demonstrated notably high baseline levels of focus while using the tool, with further improvements occurring both within individual sessions and across multiple sessions over time. Students also showed an enhanced growth mindset about their ability to focus, greater confidence in knowing how to train this ability, improved classroom focus (among those initially reporting focusing less than they ideally should), and better emotional regulation.

The null effect for independent work focus may be attributable to measurement limitations. The single-item Likert scale may lack sufficient precision to detect meaningful changes, informing our decision to implement a more sensitive percentage-based measure in Study 2.

Study 2

Study 2 provided an opportunity to replicate the findings from Study 1 using a pre-registered design with new participants in the fall semester.

Study 2: method

The research design and procedure were nearly identical to those of Study 1, providing a direct replication with a few methodological refinements. To enhance measurement precision and sensitivity to change over time, we replaced the single-item measure of focus during independent work (rated on a 1-to-6 scale) with an adapted version of the two-item classroom focus measure (Mrazek et al., 2020a, 2022), substituting references to *class* with *independent work* and using a 0% to 100% scale. Additionally, a single item in the pre-test survey asked whether the student had ever received a diagnosis of attention-deficit/hyperactivity disorder. Finally, we shortened the survey by removing the Emotion Regulation Questionnaire in order to optimize survey response quality.

Rather than excluding students who failed attention checks, as was done in Study 1, we implemented pre-registered weighting to reduce their influence while retaining their data (passed both checks: 1.0; failed one: 0.66; failed both: 0.33). To assess the impact of weighting, sensitivity analyses compared results when applying the pre-registered weights, when including all participants, and when excluding those who failed the attention check. In all cases, statistical significance at the $p = .05$ threshold was unchanged.

Participants

Eight middle and high school teachers participated, representing nine public schools in California, Washington, South Dakota, Michigan, and North Carolina. There were 695 students who completed the pre-test, and 654 completed the post-test. Real-time check-in data were available for 615 students. All available data were used for each analysis. For analyses involving the pre-test or post-test survey data, pre-registered weighting was applied to the 63 students who failed the attention check in either the pre-test or post-test.

Demographics are reported for the sample of students who completed both the pre-test and post-test. Eight of these 604 matched students did not answer demographic questions. The remaining sample ($n = 598$, 47% female) included 67 eighth graders (11%), 400 freshmen (66%), 44 sophomores (7%), 81 juniors (13%), and 5 seniors (1%). Ages ranged from 13 to 20 ($M = 14.37$, $SD = 0.95$). Racial/ethnic identification: White/Caucasian—224 (38%); Hispanic/Latino—121 (20%); Black/African American—31 (5%); Asian—124 (21%); Multiracial—54 (9%); American Indian/Alaskan Native—5 (<1%); Native Hawaiian/Pacific Islander—5 (<1%); Other—13 (2%); Prefer not to say—19 (3%).

Free and reduced lunch rates ranged from 2 to 91%, with a mean of 39.9% ($SD = 29.6\%$), based on publicly available school demographic data. Parental education was assessed by asking students to report the highest level of education completed by any of their parents/guardians; 38 (6%) of students reported ‘Some high school,’ 44 (7%) ‘High school graduate,’ 54 (9%) ‘Some college,’ 187 (31%) ‘College graduate,’ 139 (23%) ‘Post-graduate degree,’ and 134 (22%) indicated ‘I don’t know’.

Hypotheses and pre-registration

Study 2 tested the same core hypotheses as Study 1, expecting improvements in growth mindset, self-efficacy, and classroom focus. To better assess focus during independent academic work, we refined our measure and specifically hypothesized improvements among students who initially reported focusing less than they believed they ideally should. Additionally, based on findings from Study 1, we pre-registered several new hypotheses: (1) focus would increase within sessions while using the Focus Coach tool, (2) focus would improve across multiple sessions over time, (3) overall focus during independent work would improve, as measured by pre-test and post-test survey responses, and (4) these improvements in focus during independent work would be greatest among students who completed more sessions with the tool. Pre-registered study procedures, measures, hypotheses, anonymized data files, codebooks, and syntax files are publicly available at <https://osf.io/c395s>.

Study 2: results

Intervention dosage

On average, students completed 92.7% of the online course (range = 77–100%) and 5.3 Focus Coach sessions ($SD = 2.8$, range = 0–25). There was some variability in dosage across the 23 classrooms (course completion by classroom: $M = 92.7$, $SD = 4.8$, range: 76.8–100.0; completed Focus Coach sessions per student by classroom: $M = 5.0$, $SD =$

1.4, range: 2.1–7.9). Sessions averaged 16.3 minutes in active duration ($SD = 12.1$, range = 5.0–166.5). In an average session, students answered 2.8 check-ins ($SD = 1.5$) and missed 0.5 check-ins ($SD = 0.9$).

Convergent validity of check-ins

Real-time focus reported at check-ins was positively associated with pre-test measures of students' classroom focus ($b = 0.007$, $SE = 0.002$, $t(535.1) = 4.92$, $p < .001$) and their focus during independent work ($b = 0.007$, $SE = 0.001$, $t(537.0) = 4.98$, $p < .001$).

Mindsets about focus

From pre-test to post-test, students reported a higher growth mindset regarding their ability to focus and more self-efficacy in knowing how to improve this ability (Table 2).

Real-time focus

Students reported high levels of focus while using the tool ($M = 4.32$, $SD = 0.95$, range = 1–5). Students' real-time focus increased within a session, $b = 0.03$, $SE = 0.005$, $t(7716) = 6.52$, $p < .001$ (Fig. 2). This suggests that when stabilizing for random effects, each additional check-in increased students' reported focus by an average of .03 points on the 1–5 scale. Furthermore, students' real-time focus increased as they completed more sessions over time, $b = 0.03$, $SE = 0.005$, $t(3045) = 6.16$, $p < .001$ (Fig. 2). This suggests that when stabilizing for random effects, each additional session increased students' reported focus by an average of .03 points on the 1–5 scale.

As in Study 1, we conducted exploratory sensitivity analyses to examine the dynamics and robustness of the effects. For analyses progressively removing later observations, both the within-session and across-session effects remained statistically significant at the $p < .05$ threshold at each iteration, down to analyses that included only the first two check-ins within a session or the first two sessions across the semester. This suggests increased focus emerged early in tool use. For analyses progressively removing the earliest observations, the within-session effect remained significant until the first two check-ins were excluded, while the across-session effect remained significant until the first four sessions were excluded. This suggests that improvements in focus continued across multiple sessions.

A third sensitivity analysis confirmed that the across-session effect remained significant when restricting the sample to the 87 students diagnosed with attention-deficit/hyperactivity disorder, $b = 0.04$, $SE = 0.01$, $t(400.9) = 2.68$, $p = .008$. However, the within-session effect was no longer significant, $b = 0.01$, $SE = 0.02$, $t(1047) = 0.91$, $p = .36$.

Classroom focus

At pre-test, students felt they should ideally focus on class 81.0% of the time ($SD = 20.9$) but reported actually focusing 71.6% of the time ($SD = 21.0$). There were 67.9% of students who felt they focused less than they should. Among this a priori subset, classroom focus significantly increased from pre-test to post-test (Table 2).

Table 2 Means (M), standard deviations (SD), and pre-post changes in Study 2

Measure	Pre-test <i>M</i> (SD)	Post-test <i>M</i> (SD)	<i>b</i>	SE	<i>t</i> (df)	<i>p</i>	SMD
Growth mindset (1–6 scale)	4.8 (0.7)	5.1 (0.7)	0.24	0.03	8.45 (601.83)	<.001	0.34
Self-efficacy (1–6 scale)	4.1 (1.0)	4.6 (0.9)	0.59	0.04	14.37 (615.95)	<.001	0.60
Classroom focus for students with RTG (0–100%)	68.8 (20.9)	72.2 (20.1)	3.40	0.92	3.71 (408.45)	<.001	0.16
Independent work focus for students with RTG (0–100%)	70.4 (20.7)	76.6 (19.3)	5.78	0.97	5.96 (414.71)	<.001	0.28
Classroom focus for entire sample (0–100%)	71.6 (21.0)	72.0 (21.0)	0.50	0.81	0.62 (600.70)	.54	0.02
Independent work focus for entire sample (0–100%)	74.6 (21.2)	76.9 (20.4)	2.18	0.82	2.66 (607.39)	.008	0.10

SMD standardized mean difference effect size

Note Room to grow (RTG)—corresponding to lower actual focus than ideal focus at pre-test—was determined separately for focus during class vs. independent work. Analyses for classroom focus and independent work focus across the entire sample were exploratory

Focus during independent work

At pre-test, students felt they should ideally focus during independent work 85.2% of the time ($SD = 18.8$) but reported actually focusing 74.6% of the time ($SD = 21.2$). There were 67.8% of students who felt they focused less than they should. Among this a priori and pre-registered subset, focus during independent work significantly increased from pre- to post-test (Table 2). This increase was larger for students who completed more sessions, $b = 0.61$, $SE = 0.28$, $t(378.0) = 2.20$, $p = .028$.

An exploratory analysis determined that the increase in independent work focus was also significant across the entire sample (Table 2), with greater improvements in independent work focus associated with a higher number of completed sessions, $b = 0.57$, $SE = 0.25$, $t(177.9) = 2.28$, $p = .024$.

Study 2: discussion

Study 2 was a direct, pre-registered replication that confirmed the findings of Study 1. Using a more sensitive measure, it also found improvements in students' focus during independent work, not only among those who initially felt less focused than they should be but also across the entire sample. The greatest gains were seen in students who completed more sessions.

General discussion

The present studies provide evidence that a digital tool designed to integrate attention training into academic work can lead to meaningful improvements in students' focus. Across two naturalistic studies, including a pre-registered direct replication, students demonstrated improvements in real-time focus both within individual sessions and cumulatively across multiple sessions. Sensitivity analyses revealed that improvements in focus emerged early in tool use and continued to increase over time. The across-session improvement in focus was also present among students with attention-deficit/hyperactivity disorder.

Among students who initially felt less focused than they should be, overall self-reported classroom focus increased from pre-test to post-test by 3% and focus during independent work improved by 6%—with greater tool use leading to larger gains in independent work focus. Given the typical U.S. school schedule, a 6% increase in focus corresponds to roughly two hours of additional time-on-task each week. Students also reported a stronger growth mindset regarding their ability to improve focus, greater confidence in knowing how to do so, and enhanced emotional regulation (Study 1). These findings highlight the potential for integrating attention training into everyday classroom activities in a way that is adaptable across different educational contexts.

Even with effective instruction on how to train attention, many students will struggle to develop attentional control independently due to self-regulatory challenges that hinder consistent practice (Cloughesy et al., 2020; Mrazek et al., 2020b). Yet teachers have little class time to dedicate to attention training, making it valuable to incorporate training into the academic work students are already doing. This approach not only circumvents time constraints but also minimizes the need for new skills to transfer from an artificial training

context to real-world activities. Still, greater benefits could emerge if students learn to concentrate even outside of tool use. The observed results—including cumulative gains across sessions and improved focus during class and independent work—suggest the potential for broader skill development, though further research is needed to determine whether these benefits extend beyond tool use and persist over time.

A key challenge in evaluating the tool's impact is the lack of a direct comparison to students' attention when engaged in work without the tool. Because the tool itself provides the mechanism for tracking attention in real time, it is not possible to assess what those trajectories would have looked like in its absence. However, existing research suggests that sustained attention typically declines over time within a given session (Young et al., 2009). Additionally, Rosen and colleagues (2013) conducted an observational study tracking students' minute-by-minute distractions while working on an important task and found substantial attentional fluctuations but no overall trend toward improved focus over time. Given this prior work, the increasing focus observed while students used the tool runs counter to what would typically be expected.

While the combination of a pre-registered replication, within-subjects design, complementary self-report measures of focus, and sensitivity analyses provides converging support for the robustness of the findings, several limitations warrant consideration. Most notably, our single-group pre–post design does not permit strong causal claims. Increases in focus observed within and across sessions may partly reflect expectancy effects, teacher facilitation, or reactivity to repeated measurement rather than tool-specific mechanisms. Although our models accounted for clustering at the teacher level, this does not eliminate the possibility that teacher or classroom practices contributed to improvements. To address these concerns, future research should include an active control—for example, a time-matched digital timer that is framed as being supportive of focus.

Another key limitation was the reliance on self-report measures of focus. Our primary outcome was self-reported focus elicited by intermittent check-ins during independent work. In prior research, this in-situ experience-sampling approach has shown convergence with trial-level performance and neural signatures (Mrazek et al., 2012; Smallwood et al., 2008). In our data, check-ins were positively associated with independent, pre-test survey measures of focus, providing convergent validity with distinct measures collected outside of tool use. Nevertheless, these check-ins are best construed as proxies for perceived attention rather than objective attention *per se*. To strengthen inference, future studies should triangulate check-ins with complementary indicators (e.g., third-party observation, device-level data such as app/window switching, and low-burden physiological indices) and test whether improvements replicate across modalities.

Students who used the study tool more frequently demonstrated greater gains in real-time focus. This pattern suggests that tool engagement contributed to the observed improvements, although causality cannot be firmly established within the present design. Because the study tool was integrated within a broader intervention that also included an online attention-training course, it is not possible to disentangle the unique effects of these components. While the combined intervention was evaluated as it is intended to be used in schools, future research could employ dismantling or factorial designs to clarify the distinct and overlapping contributions of the course and the study tool.

Another direction for future research is assessing how well the intervention generalizes to different populations and learning environments. The observed effects emerged among a diverse sample of adolescents across multiple schools, but further studies should explore how factors such as age, cultural background, academic motivation, learning disabilities, or teacher facilitation influence outcomes.

Overall, these findings underscore the importance of applying scientific insights and established design principles to the development of educational interventions that promote academic focus. As a modern crisis of inattention continues to hinder students' ability to engage deeply in learning, these findings demonstrate that meaningful improvements are possible. While no single intervention can resolve the complex issue of distraction, embedding evidence-based strategies into everyday learning environments represents a promising way forward. Moreover, supporting students in learning to regulate their attention is not just about improving academic performance. Attention is a foundational cognitive skill with far-reaching implications for self-regulation, mental health, interpersonal relationships, and career readiness. Amidst a thriving attention economy, students need more support in developing this skill than ever before.

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Data availability Data are available on OSF. Direct links are provided in the hypotheses and pre-registration section for each study.

Materials availability Materials are available on OSF. Direct links are provided in the hypotheses and pre-registration section for each study.

Code availability Code are available on OSF. Direct links are provided in the hypotheses and pre-registration section for each study.

Declarations

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

Ethical approval The Human Subjects Committee at the University of Texas at Austin reviewed and approved the project, determining it qualified as program evaluation and quality improvement.

Informed consent As the project was classified as program evaluation and involved activities conducted as part of routine school programming, formal consent procedures were not required.

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