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Integrating attention training practices (mindfulness) into engineering education during the COVID-19 pandemic

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Abstract

Since early 2020, the implementation of strict lockdown measures due to the COVID-19 pandemic has posed several challenges for higher education. In addition to increased levels of stress, anxiety, and depressive thoughts, the sudden shift to virtual classes has affected the quality of the learning process. In recent years, mindfulness practices have shown their potential to improve student mental health and attention regulation. This study presents how the author has integrated mindfulness-based attention training practices into engineering courses during the pandemic. The author explores the perception of 108 engineering students about the main difficulties of virtual education and how the practice has helped to cope with them. Findings show that "lack of attention" has been the main challenge experienced by students. The author presents a theoretical framework to understand multiple sources of distraction and interruption affecting students' capacity to pay attention; and how the mindfulness practice can help to better notice, manage, and correct for this interference, improving concentration and engagement during class.

Keywords: *Engineering Education, Mindfulness, Attention Regulation, COVID-19, Online Teaching and Learning.*

Introduction

Wheather studying, working, relating to others, or in any other activity, *attention* plays a key role in peoples' ability to focus and engage with experience. Lately, there has been growing concerns about the impact digital technologies are having on students' attention, memory, academic performance, and capacity for social interaction (Uzun & Kilis, 2019).

The coronavirus disease (COVID-19) pandemic has caused an important disruption for higher education (HE), as universities had to fully migrate to online classes due to strict lockdown measures. Although the use of the internet and digital technologies in HE has significantly grown over last decade, most educators and students are novices when it comes

to effective online teaching and learning, specially in places with low access to educational tecnology and connectivity (Hamidi et al., 2011).

Since the emergence of online education programs in the early 1990s, undergraduate engineering education has been difficult to migrate online (Bourne et al., 2005). Additionally, the full *home-based learning* (HBL) environment and the proliferation of news about the spread of the disease, impose multiple sources of distraction, interruption, and worry, affecting students capacity to pay attention. The case is specially salient for students who have had to face substantial challenges including taking additional jobs to respond to financial burden and family obligations (Vielma & Brey, 2021). Perceived levels of stress, anxiety, and depression are high for engineering students, suggesting the importance of prioritizing interventions in engineering education (Jensen & Cross, 2021).

The concept of *mindfulness* is becoming increasingly ubiquitous in popular discourse as a stress-reduction technique. However, a deeper understanding of the mindfulness practice shows its potential for the development of *attention regulation* (Wasserman & Wasserman, 2019). Mindfulness-based interventions in HE have shown to have a positive impact on students' academic performance, memory, and mental health (Dawson et al., 2020).

Given how essential attention is for learning (Wu, 2015), the impact digital technologies, social media, and HBL have on HE, and the need to prioritize engineering students' mental health, we explore the integration of a mindfulness-based approach to teaching engineering courses. The aim is to leverage a deeper understanding of how students pay attention and become distracted (or interrupted), and share an evidence-based method with the potential to improve students' concentration, engagement, and learning experience.

Students difficulties during the pandemic

Colombia started implementing quarantine measures and universities closed their premises and suspended in-person classes as early as March 16 (Amariles et al., 2021). Ten months after full online classes started (January, 2021), and with the interest of exploring students' perception, a group of 108 Industrial Engineering students at Universidad Pontificia Bolivariana (Colombia) was asked the following open-ended question: *Considering the quality of your education as an engineer, what has been the most difficult thing about online classes?* All participants were third or fourth-year undergraduate students enrolled in the Optimization Methods (OM), or in the Operations Research course (OR). Using qualitative data coding, we analyzed and categorized 140 responses into following themes:

- **Lack of attention** (inability to concentrate), referring to and including responses such as: "*The level of distractions is very high, it requires a greater effort to be able to concentrate*", "*I get distracted by my phone all the time*", "*I don't pay much attention*", and "*I get distracted by doing several things at the same time.*"

- **Missing hands-on practice**, with responses such as: "*we're missing the opportunity to apply and practice what we learn, to visit manufacturing plants and organizations.*"
- **Increased academic workload**, referring to responses such as: "*it has been double the workload compared to what we were used to before the pandemic.*"
- **Household and family dynamics**: "*family problems, pets, preparing food, cleaning the house, while studying and attending classes.*"
- **Fatigue**: "*being all day in front of a computer causes back pain and eye fatigue.*"
- **Lack of interaction with classmates and professors**: "*we are losing the opportunity to relate to others, meeting people, learning to speak in public.*"

As shown in Table 1, *lack of attention* was the most predominant theme, present in more than 32% of responses. Along with "household and family dynamics", they represent 45,7% of the main difficulties perceived by the group.

Table 1. Themes and student response frequencies to survey question

Theme	*n*	%
Lack of attention (inability to concentrate)	45	32,1
Missing hands-on experience	25	17,8
Increased academic workload	23	16,4
Household and family dynamics	19	13,6
Fatigue	13	9,3
Lack of interaction with classmates and professors	11	7,9
Other	4	2,9

The importance of attention

When a student is in front of a computer screen wanting to understand and learn from an academic text or lecture, they will require the ability to selectively allocate attention to prioritize the information coming from the computer, while filtering out irrelevant stimuli. This process of information selection is the main functions of attention (Pashler, 1999).

One of the most common distinctions to make when understanding attention is between *external* and *internal* attention (Chun et al., 2011). External attention refers to the selection and filtering of sensory information and stimuli from the environment (sounds, sights, tastes, smells, sensations). Internal attention, refers to the selection and filtering of internally generated information from the mind (memories, ideas, impulses, emotions, mental narratives). A second distinction to make is between *goal-directed* attention (top-down) and *stimulis-driven* attention (bottom-up). Top-down attention is a *volitional* process, while bottom-up attention is an *automatic* unintentional process (Katsuki & Constantinidis, 2014). Examples of top-down attention include the decision to focus on a lecture. It refers to the intentional process by which information or stimuli is actively selected for further processing.

Bottom-up attention refers to the process by which information selection is influenced by highly noticeable (distracting) features of stimuli. Examples of bottom up attention include students automatically checking their phone in the middle of a lecture without having a clear reason to do so. These two processes are occurring one after the other, modulating students' engagement and learning.

Interference

The concept of interference refers to something that obstructs or derails some other process or activity. As a student engages in any goal-directed act of attention (e.g. completing an assignment), interference can be caused either by *interruptions* or *distractions* (Ziegler et al., 2018). Interruptions refer to any attempt to simultaneously engage in multiple tasks (multi-tasking). Imagine the student that has decided to complete the assignment and receives a notification from his/her cellphone. The student checks the phone and engages in a chat conversation while trying to finish the assignment. This is an example of interruption. Distractions refer to any information that is irrelevant to the current goal and that the student wants to ignore or suppress. As seen in Figure 1, interference can be can be generated externally or internally. Internal distraction, known as mind-wandering, refers to the common experience when attention becomes disengaged from an activity and gets lost in thoughts about the past and the future, about worries, desires, etc.

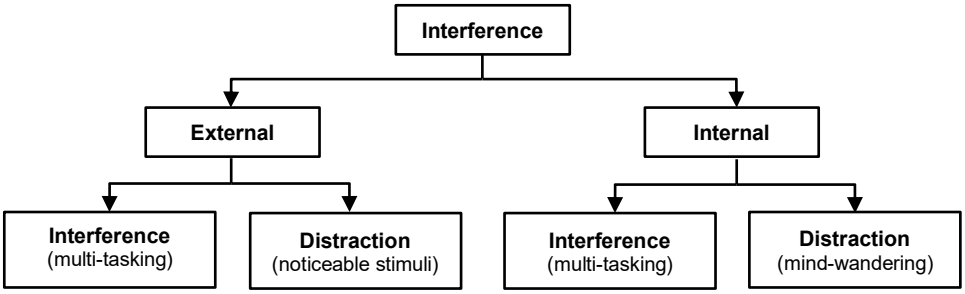

Figure 1. Framework for classifying interference
Adapted from Gazzaley (2016)

Fluctuations between goal-directed attention and interference are constantly competing for cognitive resources, impacting students' concentration, cognition and behavior (Loeffler et al., 2019). Many sources of distraction and interruption are associated with lower academic performance and higher levels of stress, anxiety, depression, and other harmful effects (Brown, 2016; Nayda & Takarangi, 2021; Rosen et al., 2013; Vogel & Schwabe, 2016).

This understanding brings the question: what can be done about it? How to leverage this understanding to mitigate the impact online education and HBL is having on various fronts? On the one hand, there is the development of teaching methods and strategies that take this

phenomenon into account. On the other hand, there is the opportunity to offer students specific practices and exercises that they can perform to train their ability to pay attention.

Attention-training practices (mindfulness)

Mindfulness has been commonly understood as a meditation practice, a state of mind, an emotional and cognitive trait, and as a form of intervention. As a practice, it offers a systematic technique for attention training, and for developing self-awareness and self-regulation (Vago & David, 2012). In recent years, mindfulness has been successfully studied and adapted across various contexts (psychology, psychiatry, neuroscience, healthcare, and organizational behavior). As mentioned above, intergrating mindfulness into education has shown to improve students' mental health, concentration and well-being.

A mindfulness-based attention training practice can be summarized in four essential steps: focusing, interfering, noticing, and redirecting (see Figure 2). It begins with an intentional (top-down) act of attention focusing on the process of breathing, on bodily sensations, or in any other external or internal object of attention. Interference inevitable arises in the form of distraction or interruption. Noticing refers to the practicioner's self-perceived state of attention and the awareness of interference. Redirecting is the act of intentionally reorienting ("bringing back") attention to the initially selected object/s. The cycle is repeated as many times as necessary for the duration of the session.

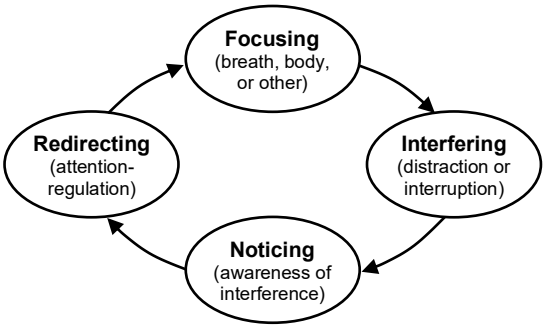

Figure 2. Mindfulness-based attention training technique

Since the start of the first academic semester (January, 2021) and until the last day of classes in May, mindfulness sessions were offered at the begging of every synchronous class (two per week). As shown in Table 2, after a quick check-in, students were invited for a full guided session. Offering the practice at the begging of the class encourages a more intentional mindset and allows students to gather attentional resources. The guidance was given by the teacher (author). Before and after some sessions, theory and reflection about the practice, its implications and utility was discussed, allowing a better understand what they are doing and why they are doing it. For longer classes (> 40 min), or classes with challenging topics, short

"mindful breaks" were offered. The sessions were all optional, and students who opted-out were invited to take an active pause. If students wanted to practice outside the class, they were given acces to recordings of guided sessions.

Table 2. Regular synchronous class schedule

Activity	Duration	Description
Welcoming	5 minutes	Greet and welcome students, set-up, check-in
Mindfulness practice (full session and talk)	5 to 10 minutes	Optional guided mindfulness session (5 to 10 minutes)
Class	40 to 50 minutes	Lecture, discussion, problem solving, other class activities
"Mindful-break" (short session)	3 to 5 minutes	Optional guided mindfulness session (2 to 3 minutes)
Class	30+ minutes	Lecture, discussion, problem solving, other class activities

Three different but related types of practices were offered: basic mindfulness (focused attention on the breath), open monitoring (open and receptive attention), and the body scan technique (de Bruin et al., 2020; Lutz et al., 2008). On average, 61% of students reported having participated on the guided sessions throughout all classes.

Conclusion, testimonies, and future research

At the end of the semester, students were surveyed again with the following question: *Do you consider your level of attention in class has changed in any way with the mindfulness practice?* As shown in Table 3, 81% of students said they felt some improvement in their ability to pay attention during class. Additionally, although the initial interest and purpose on the part of the students was mainly to improve their academic results, a considerable number of them also perceived a decrease in their stress levels (52%), a better capacity to respond to daily situations (54%) and better listening skills (51%).

Table 3. Self-perceived changes in levels of attention

Perceived change	%
Much better	17
Somewhat better	64
Same	17
Got worse	2

The integration of this mindfulness-based approach to teaching engineering courses has fostered a more empathetic interaction between students and teacher. It has been an opportunity to inspire students to prioritize their wellness and mental health during the

pandemic. Below are a few open testomonies shared by the group of students: *"At the beginning of every class I arrive feeling busy and stressed. This is why it is difficult for me to concentrate. The mindfulness practice allows me to start with much more concentration and disposition."* (Third-year student, OM); *"I feel more concentrated. I have been able to leave my cell-phone aside and that was something very difficult for me."* (Fourth-year student, OR); *"It is possible to be more attentive in class after the meditation. I suffer from diagnosed depression and this has also worked for me to treat my depression. I have improved academically."* (Fourth-year student, OR); *"I have always been very anxious, which generates a lot of distraction for me, but this practice helps me be calmer, lower my anxiety levels, and thus be able to pay more attention."* (Fourth-year student, OR).

Future research opportunities include the exploration and development of mindfulness-based teaching strategies considering the potential benefits of mindfulness on creative, critical, and sustainable thinking (Hensley, 2020; Holland et al., 2017).

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