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Zooming in or zoning out: examining undergraduate learning experiences with zoom and the role of mind-wandering

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ABSTRACT

The COVID-19 pandemic necessitated a systematic change in course modalities due to the nationwide suspension of in-person instruction, resulting in the transition to emergency remote distance learning via Zoom. This transition certainly facilitated affordances of flexibility and continuity, but with it brought issues of unfamiliarity, lack of confidence, anxiety, distractions, and validity from both the instructors and the student perspectives. This in situ study aimed to better understand the students' learning experiences with Zoom by assessing the social, cognitive, and behavioral factors influencing learner's mind-wandering and its effect on online engagement. Undergraduate students from 14 classes across two research institutions in California ($N = 633$) were recruited to participate in an online survey while distance learning through a pandemic. Structural equation modeling was used to conduct a path analysis to explain the factors impacting students' online engagement mediated by students' frequency to mind-wander. Study findings revealed that (1) self-efficacy and trait anxiety had significant direct effects on students' mind-wandering; (2) self-efficacy, trait anxiety, task-value beliefs, and mind-wandering had significant direct effects on students' online engagement; and finally (3) the frequency of students' mind-wandering partially mediated the relationship between self-efficacy and engagement and between trait anxiety and engagement. Identifying these structural relationships further confirmed our hypotheses on sources contributing to students' mind-wandering while learning remotely, provided insights into potential mechanisms underpinning students' online engagement, and suggests practical pedagogical learning experience design recommendations for instructors to immediately implement while teaching and learning with Zoom..

1. Introduction

Paying attention in a class, staying engaged, and actively participating in a lecture have been widely stated as critical components for learners' academic success. Given the relation between learners' attention and academic achievement [69,149,151], it has been increasingly important to identify ways in which learners' attentional engagement might be sustained. The COVID-19 pandemic necessitated a systematic change in course modalities due to nationwide orders of social distancing to mitigate spread, resulting in the suspension of in-person instruction [3,40]. Data from the United States in the fall of 2020 indicated that approximately 11.8 million (75%) undergraduate students learned from home and were enrolled in at least one distance learning course, while 7.0 million (44%) of undergraduates exclusively took distance education courses [160]. Many educational institutions, including higher education, rapidly adopted internet-mediated educational technology platforms [9,21,120], such as Zoom Teleconferencing and expanded Learning Management System (LMS) features, to support students while transitioning from in-person to emergency remote distance learning. Zoom is a web-based collaborative video conferencing platform that provides video, audio, and screensharing capabilities in order to facilitate teaching and learning remotely through the internet.

Data from the pandemic suggest this transition was not seamless, with high rates of disengagement by students, lower learning standards and levels, and higher failure rates. [49,57,85,86]. Thus, this difference raised questions about why this type of technology delivered instruction proceeded differently from in-person instruction, and one candidate theory has been that students may have much more difficulty in sustaining engagement and attention in this format [79,91]. In an effort to understand this context and implications for broader instructional

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design, this study examined a hypothesized model which: 1) identifies the indicators impacting students' mind-wandering, 2) examines factors influencing online engagement, and 3) explores students' mind-wandering as a mediating variable of student online engagement. Finally, we consider the theoretical and practical pedagogical design principles that may help to reduce students' frequency to mind-wander while learning remotely.

Mind-wandering has been defined as the phenomenon in which learners' thoughts or attention drift away from the task at hand to some unrelated thought [5,39]. Certainly, mind-wandering occurred in the classroom context where students do not always fully pay attention to the lectures prior to the emergency remote learning [103,150], but the transition to Zoom along with pandemic-related news may have further heightened students' mind-wandering. For example, Smith et al. [132] found that students were less attentive on Zoom when compared to students physically in the same classrooms with their instructor, experienced reduced attentiveness for synchronous only classes, and demonstated lower engagement for synchronous classes greater than 30 minutes. On the other hand, students described fears related to the impacts of the COVID-19 pandemic itself while also citing issues related to increased distractions, willingness to speak up in front of large online Zoom class, difficulty concentrating, lack of prior experience, increased worries, and decreased motivation with emergency remote distance learning —all of which are likely critical factors affecting students' mind-wandering [3,38,66,79,133].

Was and colleagues [152] surveyed students' mind-wandering during an online lecture and found that that task-related thoughts predicted higher levels of performance. This corroborates Risko et al.'s [115] findings that college students who mind-wandered more frequently while watching video lectures demonstrated poorer performance. As such, in addition to academic performance, the frequency of students' mind-wandering given the transition to Zoom and the negative experiences of the pandemic may also have a critical role in students' engagement. Furthermore, this study provided an opportunity to clarify how students' self-efficacy, task-value, anxieties, and online engagement are influenced by students' mind-wandering. We specifically focus on unintentional mind-wandering, which is hypothesized to be the result of shifting incentivized values, failure of executive control, and lack of meta-awareness, with the ultimate consequence of poor task engagement [80,100,115]. Additionally, student engagement is hypothesized to be higher when learners have control and some autonomy over the learning task, rather than unintentionally mind-wandering to unrelated tasks [56]. Since student self-efficacy fosters goal setting and increases students' judgments about their abilities to learn and successfully complete tasks [24,47], we would expect that students with higher self-efficacy would be less likely to lose interest and persevere on challenging tasks. Similarly, we would expect this trend in students with high levels of task-value, that is, students' evaluations of how important and useful a task might be, will likely lead to more active involvement within the course [8,34,107]. Together, students' motivations such as self-efficacy and task-value are likely to increase student involvement , thereby reducing the frequency of mind-wandering [112,113]. On the other hand, students' increased trait anxiety with regards to the drastic changes in learning modalities and the pandemic may signal a failure of attentional cognitive resources, increasing students' mind-wandering and negatively influencing students' online engagement. In a prior study conducted by the authors of this article, Mesghina and colleagues [89] found undergraduates higher in COVID-19 distress saw lower learning gains in a controlled expriment due to increased state mind-wandering during an asynchronous lesson. Building on this study, we drew from the literature to better understand how trait mind-wandering may have detrimental impacts on students' Zoom learning experiences, and identified potential factors that may contribute to the resulting effects of mind-wandering to better inform instructors, course designers, and administrators on how to accommodate learning for students. We conducted a path analysis to examine students' mind-wandering as a potential mediator impacting students' learning experiences.

2. Literature Review

The following sections provide an overview of the theorized mechanisms underpinning mind-wandering. These key bodies of literature inform the basis of our hypothesized model to characterize the student learning experience by examining whether students' mind-wandering mediates the relationship between students' self-efficacy, trait anxiety, and task-value beliefs influencing their online engagement.

2.1. *What is mind-wandering?*

Mind-wandering is the shift of an individual's attention away from a primary task at hand and towards other internalized information [125,129]. Another way to describe mind-wandering is the human experience of drifting into thoughts away from the "here and now" [129]. Unlike being in a state of focus and concentration, mind-wandering is the opposite, considered an off-task processing state such that individual experiences an attentional lapse [17,28]. At times, mind-wandering may occur consciously as an evolutionary human mechanism to evade boredom or lower cognitive fatigue; however, mind-wandering may also occur unconsciously [50]. On one hand, task-related mind-wandering, where a person starts with some thoughts related to a task and mind wanders, has been shown to exhibit benefits such as creativity and future planning [31,71]. On the other hand, task-unrelated mind-wandering, or off-task thought, is the act of mind-wandering to thoughts completely unrelated to the primary task [88,93]. Task-unrelated mind-wandering is more likely to occur during monotonous environments [32] or long cognitively undemanding tasks [130]. Conrad and Newman [25] conducted a mind-wandering study on students during the COVID-19 pandemic and found that students with greater instances of mind-wandering during 75-minute online lectures had lower learning scores (See also [89]). These authors attribute greater instances of off-task thought during online lectures due to the lack of learning design principles that may limit mind-wandering or provide corrective feedback [26,130]. Considering that Zoom lectures are often plagued by boredom, frustration, and lack of engagement [57,70], identifying potential factors that contribute to task-unrelated mind-wandering may be essential [113,122,128].

2.2. *Why does mind-wandering occur?*

Mind-wandering indicates a fault in information processing, where external task-related information shifts towards processing internal task-unrelated information [129]. This attentional shift is theorized to be a decoupling process between the task (external information) and the existing mental model (self-generated thoughts) of the individual [90,128]. In systematic reviews Smallwood [127] and Randall [113], researchers argued that the mind begins to wander due to three hypotheses: meta-awareness of an individual's conscious behavior, failure of executive control, and an individual's current concerns. Meta-awareness is the act of reflecting on one's own thinking, a conscious capacity of self-monitoring of the present "here and now" [122,129,145]. As such, this hypothesis postulates that an individual's capacity of meta-awareness, that is to recognize their own conscious thoughts and deviations from a desired goal state or performance task, can regulate the duration of mind-wandering [92,129]. Thus, meta-awareness, or specifically lack the thereof, would signal a breakdown of one's own conscious awareness or self-monitoring given a task, influencing the likelihood of mind-wandering [113,122].

In contrast to Smallwood [127], the failure of executive control hypothesis proposes that sustained external attention requires executive control in order to reduce the number of internal and external distractions [88,127]. Through this lens, mind-wandering is a derivative of a person's inability to exhibit the necessary executive control to regulate cognitive resources in order to perform or accomplish a task when encountered by distractions [69]. According to McVay & Kane [88], individuals with higher levels of working memory capacity (WMC), exhibiting more executive control, are more likely to combat distractions, preventing the onset of mind-wandering. Specifically, mind-wandering is related to cognition through the default-mode network (DMN), a large network of constellation regions of the brain supporting automatic and self-relevant information processing [43,48]. Recent studies have found that both deliberate and spontaneous mind-wandering arise through the differences in attentional regulatory control such that the DMN and executive control systems function together, allowing information from memory to contribute to a sustained train of thought [48,81,106].

It is therefore possible that mind-wandering may be closely aligned with a person's intentions. In this way, Klinger [77] argued that mind-wandering may occur as a result of an individual's shift in attention towards tasks with more value or rewarding experiences. More specifically, this perspective claims that an individual's goals, wishes, desires, concerns, and cost may play a more significant role than the task at hand, resulting in the shift of attentional focus [90,127]. As such, the current concerns hypothesis suggests that a key element contributing to the onset of task-unrelated mind-wandering is the extent to which a person's internalized thoughts hold greater incentivized value than external information (I.e., watching a Zoom lecture) [113]. Consequently, mind-wandering, in part, can be attributed to an individual's personal value placed on a given activity. If the internalized value is more rewarding, mind-wandering is likely to occur.

2.3. Factors that predict mind-wandering

These hypotheses shed light on the mechanisms explaining why mind-wandering occurs, which suggests predictors that influence mind-wandering in an online teaching and learning context. In line with the three hypotheses presented, these predictors contribute to the onset of mind-wandering which include learners' self-efficacy, trait anxiety, and task-value beliefs.

2.3.1. Self-efficacy and the Meta-awareness Hypothesis

Schooler et al. [122] argued that individuals mind-wander as a consequence of failure in conscious awareness and self-monitoring. According to this theory, people who tend to notice their conscious thoughts are more likely to realize their frequency to drift away from those thoughts [93,122]. One key factor in supporting students' conscious awareness of their skills and confidence to be successful while learning remotely is to evaluate students' self-efficacy. Self-efficacy is grounded in Bandura [159] framework of social cognitive theory, positing that an individual's cognitive, behavioral, and environmental factors all affect human performance [124,159]. More specifically, people who self-monitor their beliefs are more willing to act if they feel more motivated and confident that their behavior will ultimately result in successful outcomes [13,124]. Through this lens, Bandura [11] argued that self-efficacy may influence people's behaviors based on the cognizant monitoring of their own perceived judgments [124]. In the context of online learning environments, self-appraisal of one's ability to perform a task based on his or her own judgments has been identified as a critical factor that may influence students' mind-wandering. Since increasing self-efficacy encourages goal-setting, evaluative feedback, and persistence [22,24], we would expect that learners with higher self-efficacy will be more likely to combat distractions and thereby mind-wander less frequently. Students' self-efficacy represents the metacognitive self-monitoring of one's judgments in confidence or discomforts while learning [112,113], which has implications for effort and sustained resilience to combat task-unrelated mind-wandering occurrences [31], heightening or diminishing their task engagement while learning remotely [58]. Thus, considering students' self-efficacy aligns with the meta-awareness hypothesis as a social cognitive learning predictor of mind-wandering.

2.3.2. Executive Failure and Trait Anxiety

One major concern with emergency remote distance learning was how to best engage and sustain students' online throughout the learning experience, given broad learning challenges such as the heightened anxieties caused by the COVID-19 pandemic and the often drastically different home educational settings [3,133]. Anxiety can be defined as the feeling of fear, dread, and uneasiness in a given environment [46,134]. The anxiety that the remote learning environment produces is an important factor to consider, as extant literature has shown that anxiety is a key variable that can consume limited cognitive resources, which can negatively impact learning outcomes and task performance [36,63,72,161]. Son et al. [133] conducted surveys with undergraduate students in a large public university in the United States and reported that 71% of students experienced increased fear and anxiety due to the COVID-19 pandemic, 89% report difficulty concentrating, and 86% had persistent concerns for their academic performance due to the transition to online classes. With the transition having occurred so rapidly and students citing issues regarding accessibility, content validity, and rigor [57,118], the frequency of off-task thoughts is expected to be high.

Results from a meta-analysis showed that people with fewer available cognitive resources (working memory capacity and cognitive ability) engage in more task-unrelated thought, whereas those with more cognitive resources available are more likely to engage in task-related thought, thereby mind-wandering less [112,131]. This was exemplified in a study conducted by Hartanto and Yang [55], where anxieties related to online instruction with undergraduate students were positively associated with task-unrelated thought, which ultimately predicted lower task performance. Similarly, Mesghina and colleagues [89] found that undergraduates who were more distressed about the pandemic and those higher in trait anxiety also reported greater mind-wandering during an asynchronous neuroscience lesson. Importantly, mind-wandering mediated the relation between pandemic distress and learning from the lesson, again underscoring the important link between affective states and executive functions [89]. Likewise, Parks-Stamm et al. [104] identified that anxiety also influences students' attention. Drawing on the executive control hypothesis, heightened anxieties, and worries may occupy learners' cognitive resources which may explain the failure for students to maintain executive control while learning remotely, causing a shift from on-task thought to task-unrelated mind-wandering.

2.3.3. Current Concerns Hypothesis and Task-value beliefs

Drawing on the current concerns hypothesis [76–78], mind-wandering is suggested to be driven by the current concerns that are relevant to the individual. Social cognitive theorists of behavior and motivation link students' task-value beliefs to students' learning, where an individual's perceived value influences their action-outcome expectancy [8,108]. Eccles & Wigfield [34] define task value as the ability for individuals to evaluate their competence, interests, costs, and broad beliefs in a particular domain characterized into four components: attainment value, intrinsic value, extrinsic utility value, and cost. In practice, task-value references students' perceived interests, importance, usefulness, and "worthwhileness" when participating in a learning task [107], which parallel Klinger et al. [78], claiming that goals, concerns, and worries may outweigh the attentional capacity of the primary task at hand. Students are likely to invest greater effort and allocate more cognitive resources if learners perceive the learning environment to have high personal incentivized value [23,64].

Many courses rapidly subscribed to the Zoom internet-mediated teleconferencing for distance learning. However, this potentially compromised learners' motivation and engagement. Adnan and Anwar [2] found that 71.4% of undergraduate students reported that learning in conventional face-to-face classrooms was more motivating than distance learning remedies, specifically raising concerns related to the inability to actively participate with their instructor and classmates. Hence, learners' task-value beliefs while learning via Zoom may likely be low, resulting in the shift of incentivized value [90,127] and increasing the frequency of task-unrelated mind-wandering [144].

2.4. Consequences of mind-wandering with Zoom teaching and learning

Given that task-unrelated mind-wandering represents a detached attentional state, we would expect to see mind-wandering specifically for students learning under the emergency remote distance learning contexts. Task-unrelated mind-wandering is more likely to occur during monotonous environments [32] or long cognitively undemanding tasks [130]. Since online "Zoom school" was a rapid response solution to the pandemic, rather than a fully planned online course grounded in learning design pedagogies [57], class sessions were ultimately the same instructor-centered lectures delivered online with arguably little to no student-centered interaction, or active discourse [45,135]. These perhaps monotonous learning environments may contribute to task-unrelated mind-wandering which can potentially be detrimental, as active information processing requires explicating information from the learning environment and aligning this new information through the process of elaboration [90,128]. This process helps students build internal connections with their existing mental models that are ultimately consolidated into long-term memory [51,102,107]. As such, task-unrelated mind-wandering halts this coupling process of internal (self-generated) versus external (learning environment) alignment of information and may be a related factor for students' negative task engagement.

This attentional shift can come in many forms when considering the pandemic, health, family, or the wellbeing of others. Ragan and colleagues [111] found that 63% of students were disengaged or "off-task" during large university lecture courses due to distractions to media browsing. Unsworth and McMillan [144] revealed that learners' self-distraction in the classroom was typically due to technology use. Additionally, Wammes et al. [149] found that media multitasking led to negative learning outcomes and disengagement during lectures, with the latter part of the of lecture sessions showing increased disengagement towards external distractions such as phones and media devices. Further, Randall et al.'s [112] meta-analysis also corroborates findings that as students' task attentional demand decreases, mind-wandering increases [100,115]. Thus, when online courses lack interactivity, are uninteresting, or are cognitively undemanding, these will likely contribute to negative task engagement behaviors influenced by students' mind-wandering [31,32].

2.4.1. Engagement

One way to predict students' on-task thought is to consider students' task engagement within the online learning environment. In the field of education, student engagement has been conceptualized as a multidimensional construct consisting of three components of engagement: behavioral, cognitive, and emotional [44]. Behavioral engagement refers to the amount of student involvement, active participation, and physical performance required to complete a learning task in an academic setting [35,61]. Such engagement also includes behaviors like time on task, homework completion, and class attendance [7]. Cognitive engagement is the level of mental investment exhibited by the student throughout the learning process. These factors are more internal, comprising of self-regulation, autonomy, alignment of schoolwork with career trajectories, strategy and thought, and the willingness to exert the necessary effort for comprehension or mastery of complex conceptual ideas [7,44]. Emotional engagement is the positive and negative reactions extrapolated from a particular task situated within an instance of learning [44]. This notion is further extended by considering learners' emotional experiences such as joy, belonging, appreciation of success, and excitement [52,101]. Student engagement has been found to have a significant and positive relationship with student outcomes such as students' progress in learning, course satisfaction, and course grades [6,14,16,105,138]. Additionally, increased engagement has been shown to predict increased completion rates, reduce dropouts, and foster transferable skills such as self-regulation and critical thinking [45].

Identifying factors that contribute to and influence high levels of student online engagement while distance learning is important. Student engagement is hypothesized to increase when learners exhibit interests, control, and some autonomy over the learning task [56]. Online courses that are instructor-focused and lack student-centered activities are often plagued with students feeling uninterested, disengaged, and increased absenteeism due to increased mind-wandering [31,32,57,133]. For example, Wong and Lim [156] found that learners who engaged in long-hand notetaking demonstrated less mind-wandering during online lectures, leading to greater course performance than those who took photos or did not engage in note-taking at all. Wong and Lim [156] further revealed that mind-wandering mediated the impact of note-taking strategies on the video lectures. As the mind starts to wander, the ability to monitor one's performance and behaviors is reduced, making one more prone to mistakes while learning [67,68]. This attentional lapse is hypothesized to be a detrimental source for students' disengagement [139]. Additionally, since many students were first-time distance learners, students' self-efficacy, or judgments about their confidence and ability to succeed in an online course, are likely to be low, influencing the extent to which learners engage and interact with distance learning [162]. Conversely, students with high levels of self-efficacy are likely to be more engaged in the online course, actively monitoring their performance and setting goals to continually accomplish the course requirements [24]. Furthermore, given the rapid transition to distance learning, the quality of emergency remote distance learning may differ drastically to online learning grounded in instructional design principles, affecting students' task-value or perceived worthwhileness and validity of participating in the course [57,65]. Moreover, negative thoughts may disrupt task engagement, as anxiety, or feelings of worry specifically, take up limited cognitive resources [10,28]. As such, this study examined the relationship between students' self-efficacy, trait anxiety, task-value, and mind-wandering on students' online engagement, and tested students' mind-wandering as a mediating factor during the rapid conversation to emergency remote distance education.

2.5. Current Study

In a previous study, we investigated the role of mind-wandering in undergraduates' learning during the COVID-19 pandemic [89]. Using an asynchronous neuroscience lesson, we found that individuals who were more distressed about the pandemic demonstrated lower learning from the lesson. Importantly, increased mind wandering mediated this relation. We also found that trait anxiety was positively related to mind wandering during the lesson [89]. We were able to examine timely and theoretically supported relations between affective experiences, mind wandering, and learning in the moment. A remaining question, investigated here, is how these factors influence students' learning experiences and engagement during their real, everyday online classes.

Hence, this paper builds on the prior literature on distance learning and mind-wandering to examine the social, cognitive, and behavioral factors that influence students' learning experiences under these conditions. We attend specifically to the role of students' mind-wandering and students' online engagement, in relation to the online delivery of courses through Zoom. Additionally, we considered students' heightened anxieties and examined the role of students' self-efficacy and task-value. Taking these factors into account, this study represents an *in situ* survey analysis of undergraduate students examining the mediating role of students' mind-wandering and the factors that impact learners' online engagement during the transition to emergency remote distance learning. By conducting a path analysis, we were able to identify the direct and indirect effects on mind-wandering and engagement. Examining both of these effects in the context of our study, we are able to make suggestions for causal and mechanistic claims on the mediating role of mind-wandering. Through this process, we were able to explore the underlying mechanisms by which the effects influenced the outcome. Collecting student survey data allows insights into learners' actions, attitudes, and beliefs in their everyday life as they naturally occur [148]. Selecting this *in situ* observational approach enabled researchers the opportunity to elicit student information characterized by high ecological validity [146,147], as students responded to the questionnaires while fully immersed in emergency remote distance learning courses during the academic terms in the middle of a global pandemic. The present study aimed to examine the relations between self-efficacy, trait anxiety, task-value beliefs, mind-wandering, and online course engagement.

Thus, this study is guided by the following hypotheses (see Fig. 1 and Table 5):

[H1]: Students' self-efficacy will have a direct negative effect on students' mind-wandering and a direct positive effect on students' engagement.
[H2]: Students' trait anxiety will have a direct positive effect on students' mind-wandering and will have a direct negative effect on students' engagement.
[H3]: Students' task-value will have a direct negative effect on students' mind-wandering and will have a direct positive effect on students' engagement.
[H4]: Students' mind-wandering will have a direct negative effect on students' engagement.
[H5A]: Students' self-efficacy will have an indirect positive effect on students' engagement.
[H5B]: Students' trait anxiety will have an indirect negative effect on students' engagement.
[H5C]: Students' task value will have an indirect positive effect on students' engagement.

3. Materials and Methods

3.1. Ethical Considerations

This study was funded by the National Science Foundation (NSF) and Institute of Education Sciences (IES). IRB approval was obtained by the university institution in order to conduct human subjects research as mandated by the universities and the grant funder. An IRB-exempt protocol status was granted as the data collected was anonymously submitted online and posed no more than minimal risk. [1] Participants' data were recorded confidentially and anonymously and none of the questionnaires, topics, or content asked could harm students. This protocol was approved by the university ethics committee.

3.2. Research Design

This study was a cross-sectional survey analysis of undergraduate students who experienced distance learning through Zoom during the COVID-19 pandemic. Data were collected between Spring 2020 and Winter 2021 and only new students were recruited to participate while the survey was open.

3.3. Participants

Participants were undergraduate students from two large universities in California. Students were recruited from 14 different online courses across five university schools which include: the School of Education, the School of Biological Sciences, School of Social Ecology, School of Law, and School of Social Sciences. Undergraduate students were recruited to participate in this study by invitation through their course instructor.

Students were compensated with a $20 Amazon gift card upon completion of the study. Of the 2,121 students who were recruited from 14 classes, 706 students responded to surveys. Of those, 73 students were removed because they failed to meet the attention checks built into the online survey questionnaire. These questions were not relevant to the survey constructs of interests and were randomized within the survey to establish a criterion for checking if students were paying attention [99]. Students failing two or more of the attention checks questions were removed.

The final sample size was 633 students. (See Table 1 for demographic information). Public demographic data provided directly by the universities indicate that the race/ ethnicity for the 2020-21 academic was made up of 2.34% African American, 44.1% Asian/ Pacific Islander, 30.4% Hispanic/ LatinX, 15.8% White, 5.7% Multiple/ Mixed, and 1.5% other ethnic/ racial groups.[2]

3.4. Data Collection and Instrumentation

Data in this study were collected through online surveys via Qualtrics XM. Participants were provided a direct link to the survey which was emailed by their course instructors. Four questionnaires were utilized in this study which included the student demographics survey, Online Value and Self-Efficacy Scale (OLVSES), State-Trait Anxiety Inventory (STAI), Online Engagement Scale, and the Mind-Wandering Questionnaire (MWQ). When responding to all of the surveys, students were asked to reflect on their typical experiences in the class from which they were recruited.

3.4.1. Demographics Survey

The demographics survey included questions regarding participant age, gender, race/ ethnicity, and education level. Additionally, statuses regarding graduation, international, and first-generation markers were requested.

3.4.2. Online Value and Self-Efficacy Scale

To assess students' self-efficacy and task-value beliefs in an online learning environment, the Online Value and Self-Efficacy Scale (OLVSES) was employed [8]. Comprised of two sub-constructs, self-efficacy and task-value, there were a total of 11 items scored on a 7-point Likert scale ranging from 1 (*completely disagree*) to 7 (*completely agree*). Sample items include "It is personally important for me to perform well in this course" and "even in the face of technical difficulties, I am certain I can learn the material presented in an online course."

3.4.3. State-Trait Anxiety Inventory

The State-Trait Anxiety Inventory (STAI) [134] contains 20 items within two sub-scales: state-anxiety and trait-anxiety. For the purposes of this study, we only assessed students' trait anxiety. All items are rated on a 4-point Likert scale ranging from 1 (*almost never*) to 7 (*almost*

[1] The data from this manuscript are a subset of students from two studies recently published by Mesghina and colleagues (2021). The present study pooled data across both of the studies in Mesghina et al. (2021). The survey measures investigated here probed students about their typical experiences with regards to the course from which they were recruited. Mesghina, A., Wong, J. T., Davis, E. L., Lerner, B. S., Jackson-Green, B. J., & Richland, L. E. (2021). Distressed to Distracted: Examining undergraduate learning and stress regulation during the COVID-19 pandemic. AERA Open, 7(1), https://doi.org/10.1177/23328584211065721

[2] A chi-square test found no significant differences between the study participants and the universities' student race and ethnicity profiles *($\chi 2 = 16.6$, $p = .454$).*

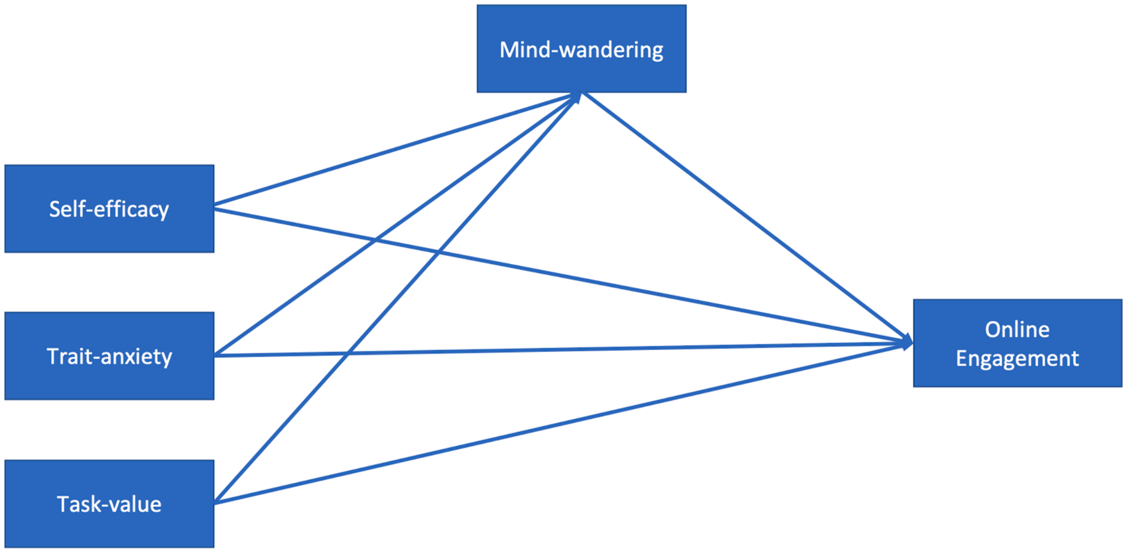

Fig. 1. The hypothesized model suggested by the literature explaining factors predicting mind-wandering and the effects of undergraduate students' online engagement.

Table 1
Sociodemographic Characteristics of Participants

Student Characteristics	Students Enrolled	
	n	%
Gender		
Woman	496	78.3
Man	128	20.2
Other	9	1.42
Race/ Ethnicity		
African American	9	1.42
Asian	280	44.2
Hispanic	216	34.1
Multiple	45	7.11
Other	14	2.21
White	69	10.9
Student Year		
First	174	27.5
Second	100	15.8
Third	198	31.3
Fourth	146	23.1
Fifth	15	2.37
International Student		
Yes	14	2.21
No	619	97.8
First Generation		
Yes	345	54.5
No	288	45.5

Note. $N = 633$
Reflects the number and percentage of participants answering "yes" to this question.

Table 2
Descriptive Statistics and Correlations for Study Variables (N = 633)

Variable	1	2	3	4	5
1. Self-efficacy	—				
2. Task-value	.174***	—			
3. Trait Anxiety	-.510***	-.004	—		
4. Mind-wandering	-.467***	.014	.568***	—	
5. Engagement	.649***	.417***	-.299***	-.365***	—
Cronbach Alpha (α)	.902	.883	.888	.887	.910
Mean	23.8	35.9	50.6	20.0	42.3
Standard Deviation	6.36	4.94	11.5	5.17	7.93
Skewness	-.520	-1.08	-.117	-.402	-.449
Kurtosis	-.023	2.35	.194	.095	.730
Tolerance	.662	.955	.599	.632	—
Variance Increase Factor	1.51	1.05	1.67	1.58	—

***. Correlation is significant at the 0.01 level (2-tailed).

always). Sample items include "I get in a state of tension or turmoil as I think over my recent concerns and interest" and "Some intrusive thought runs through my mind and bothers me."

3.4.4. Online Engagement Scale

To assess students' perceived online engagement, we utilized the 12-item perceived engagement scale [117]. Response options were on a 5-point scale, 1 (*completely disagree*) to 5 (*completely agree*). The construct consisted of questions about students' perceptions of learning and their perceived engagement in an online course. Sample items include, "When I am in the online class, I just 'pretend' as if I am learning" and "If I do not know about a concept when I am learning in the online class, I do something to figure it out."

3.4.5. Mind-Wandering Questionnaire

The Mind-Wandering Questionnaire (MWQ), developed by Mrazek and colleagues [92], was deployed to assess students' typical experiences of mind-wandering in the course they were recruited. This instrument includes five items with response options on a 6-point Likert scale, 1 (*almost never*) to 6 (*almost always*). Sample items include "I mind-wander during lectures or presentations" and "I find myself listening with one ear and thinking about something else at the same time."

3.5. Preliminary Data Analysis

Data were analyzed using SPSS to conduct scale reliabilities, descriptive statistics, missing data analysis, correlations, and SPSS AMOS for structural equation modeling. Full information maximum likelihood (FIML) was utilized as the missing data estimation approach to account for data missing at random, maximizing the case-wise likelihood of the observed data [18,153]. Then, preliminary analysis tested assumptions of sample size, multivariate normality, linearity, and multicollinearity of the variables of interest. Lastly, bivariate correlation analysis evaluated the linear relationships between the different study variables.

3.5.1. Assumptions of Sample Size, Normal Distribution, and Multicollinearity

To fulfill the requirements to perform a path analysis, assumptions regarding sample size, multivariate normal distribution, and multicollinearity were examined. A sufficient sample size for analysis is twenty times greater than the number of indicator variables utilized in the model [73]. As such, a sample size of 100 was determined to meet the provisions of a necessary sample for a path analysis that contained five variables. To confirm multivariate normality, the mean, standard deviations, and the skewness and kurtosis of the measured variables were calculated. Normal distributions are met with acceptable values between -3 and 3 for skewness, and -10 and 10 for kurtosis when utilizing structural equation modeling [15,75]. Table 2 documents that the current study data fulfills the assumptions of multivariate normality. Furthermore, assumptions of multicollinearity were tested by calculating the variance increase factor (VIF) and tolerance values. Hair and colleagues [53] indicate that if the VIF values are greater than 5 and tolerance values are less than 0.1, then multicollinearity exists. Table 2 shows that the VIF and tolerance values are within the specified range for the variables of interest.

3.6. Data Analysis Plan

SPSS AMOS 28.0 was used to conduct a path analysis using the maximum likelihood estimation (MLE) in order to analyze the hypothesized research model. The direct and indirect relationships between the variables of trait anxiety, self-efficacy, task-value, mind-wandering, and online engagement were defined. More specifically, we conducted a covariance-based path analysis, a subset of structural equation modeling (SEM), with a maximum likelihood estimation (MLE) approach to examine our research questions and hypotheses with measured variables [83,143]. Fit indices such as the goodness of fit test conformity (Chi-square statistic), the goodness of fit index (GFI), comparative fit index (CFI), normed fit index (NFI), and the root mean square error of approximation (RMSEA) were calculated [74,123]. Initially, a fully saturated model was conducted to test our hypothesized model. We respecified our hypothesized model by making stepwise modifications to achieve a more parsimonious model with higher levels of model fitness [59,143]. Based on these test results, unique direct and indirect effects were analyzed to examine the factors influencing students' mind-wandering and online engagement.

4. Results

Table 2 summarizes the descriptive statistics for scale constructs used in this study. Bivariate Pearson correlations document the linearity between the endogenous and exogenous variables in Table 2. All study variables indicated significant linear trends except for the relationship between students' task-value and their trait-anxiety, as well as task-value and mind-wandering.

4.1. Testing the Hypothesized Model

In the initial path analysis, we tested a fully saturated hypothesized model, analyzing the conformity indices and direct effects of trait-anxiety, self-efficacy, task-value, and mind-wandering influencing students' online engagement (Fig. 2). The model showed satisfactory goodness of fit, although the TLI and NFI were below 0.95 (See Table 3). The direct effects of students' self-efficacy (β = .578, p < .001), task-value (β = .124, p < .001), trait-anxiety (β = -.052, p < .075) and mind-wandering (β = -.052, p < .001) on online engagement were statistically significant. In addition, the effects of both students' trait-anxiety (β = -.464, p < .001) and self-efficacy (β = -.269, p < .001) on mind-wandering was statistically significant. However, the direct effect of students' task-value (β = .064, p > .05) on mind-wandering was not statistically significant. As a result, this nonsignificant pathway was

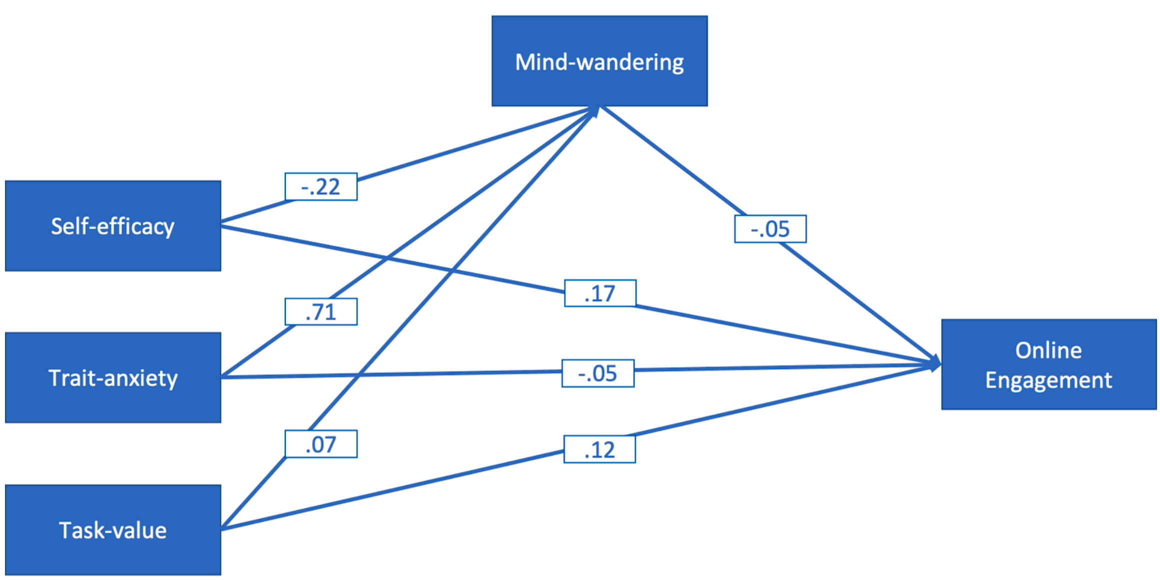

Fig. 2. The standardized path coefficients of the hypothesized model suggested by the literature explaining factors predicting mind-wandering and the effects on students' online engagement.

Table 3
Fit Statistics for the hypothesized and respecified structural model (N = 633). The criteria for the goodness of fit can be found here [60,73,75,123].

	CMIN (χ^2)	Df	GFI	CFI	TLI	NFI	RMSEA	SRMR
Initial structural model	3.49	3	.918	.976	.811	.996	.063	.023
Respecified structural model	7.76	3	.998	.997	.974	.996	.063	.001
Criteria	—	—	>.95	>.90	>.95	>.95	<.08	<.08

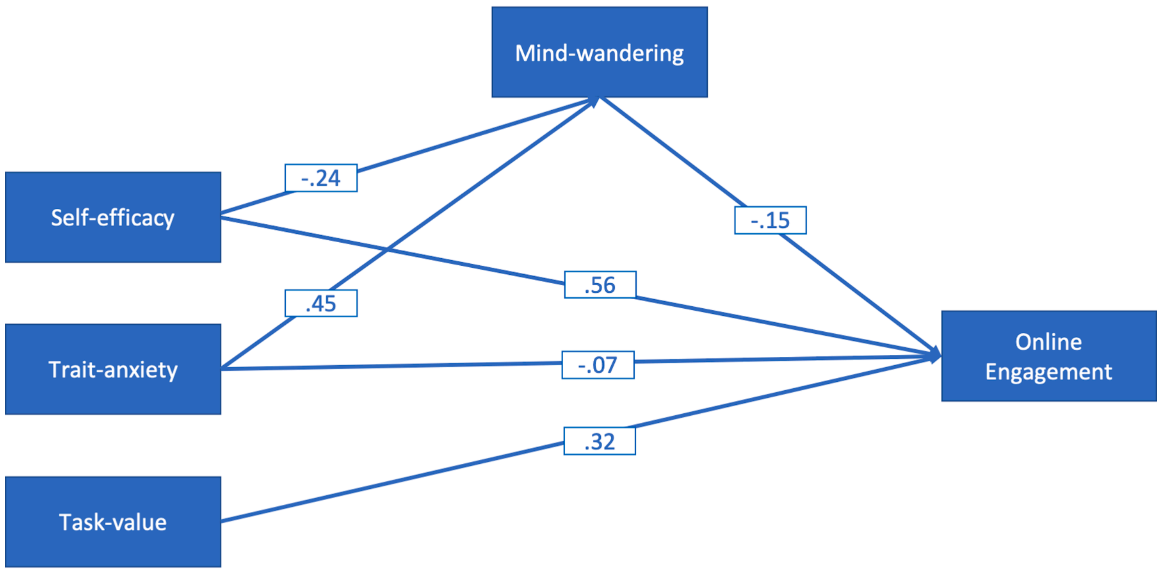

Fig. 3. The standardized path coefficients of the respecificied model suggested by the literature explaining factors predicting mind-wandering and the effects on students' online engagement.

removed, and the final model was respecified (See Fig. 3).

4.2. Testing the Respecified Model

4.2.1. Model Fitness

To evaluate the model fitness of the competing model, the goodness of fit measures of the respecified path model were calculated (See Table 3). A Chi-square test was computed to compare the statistical significance between the two competing models [121]. Results confirmed there was no statistically significant difference between the hypothesized and final respecified models in terms of the goodness-of-fit ($X^2 = 4.267$, $p = .118$). As such, the more parsimonious respecified model was retained. See Fig. 3 for the final model with standerdized path coefficients.

4.2.2. Direct Effects on Mind-wandering

Table 4 provides all direct and indirect effects for the respecified model. The standardized beta coefficients of the direct effects revealed that students' self-efficacy (β = -.240, $p < .001$) had a significant negative direct effect on students' mind-wandering. Meanwhile, students' trait-anxiety ($\beta = .445$, $p < .001$) had a significant positive direct effect on students' mind-wandering. Students' self-efficacy and trait-anxiety together accounted for 36.5% of the variance in students' mind-wandering.

4.2.3. Direct Effects on Engagement

Second, examining the direct effects of on students' online engagement, we found that students' self-efficacy ($\beta = .559$, $p < .001$) and task-value ($\beta = .321$, $p < .001$) were both positive and statistically significant. Meanwhile, students' trait-anxiety (β = -.073, $p < .05$) mind-wandering (β = -.149, $p < .001$) had a negative significant direct effect on students' online engagement. Students' self-efficacy, task-value, trait anxiety and mind-wandering accounted for 53.0% of the variance in students' online engagement.

4.2.4. Indirect Effects

As the aforementioned direct effects were significant, the mediating effects of students' mind-wandering were explored. We tested the indirect effects of students' mind-wandering on (1) students' self-efficacy and students' online engagement and (2) students' trait anxiety and students' online engagement. The indirect effect of students' task-value was not tested in this final model because of the removal of the non-significant pathway after selecting the final model. The standardized indirect effect of students' self-efficacy on their online engagement was significant ($\beta = .036$, $p < .001$). In addition, the standardized indirect effect of trait anxiety on online engagement was significant (β = -.066, $p < .001$). Since the direct effect of self-efficacy on online engagement was statistically significant, mind-wandering partially mediated the relationship between self-efficacy and online engagement. Similarly, mind-wandering partially mediated the relationship between trait anxiety and online engagement.

4.2.5. Total Effects

Self-efficacy and trait anxiety had statistically significant total effects on students' mind-wandering. The total effect of trait anxiety ($\beta = .445$) was larger than that of the total effect of self-efficacy (β = -.240).

Table 4
Effect decomposition for the respecified model (N = 633)

			Unstandardized			Standardized		
			Total	Direct	Indirect	Total	Direct	Indirect
Mind-wandering	←	Self-efficacy	-.209	-.209*	.000	-.240	-.240*	.000
	←	Trait-anxiety	.726	.726*	.000	.445	.445*	.000
	←	Task-Value	.000	.000	.000	.000	.000	.000
Engagement	←	Self-efficacy	.171	.163*	.009*	.595	.536	.036*
	←	Trait-anxiety	-.030	.000*	-.030*	-.053	-.073*	-.066*
	←	Task-Value	.125	.125*	.000	.321	.321*	.000
	←	Mind-wandering	-.041	-.041*	.000	-.149	-.149*	.000

*p < 0.05.

Additionally, students' self-efficacy, task-value, trait anxiety, and mind-wandering had a statistically significant total effect on students' online engagement. The total effect self-efficacy (β = .595) was greater than task-value (β = .321), trait anxiety ((β = -.053) and mind-wandering (β = -.149). The results indicated that students' mind-wandering was a meaningful mediator for the relationship between self-efficacy and online engagement as well as trait anxiety and online engagement.

5. Discussion

In a prior study by Mesghina et al. [89], the role of mind-wandering in undergraduates was examined in a controlled experiment where mind-wandering mediated the relationship between pandemic-related distress and in the moment learning. In the present study, we investigated undergraduates' typical learning experiences during their remote online Zoom classes and examined factors contributing to students' frequency to mind-wander. Our study findings revealed that (1) self-efficacy and trait-anxiety had a significant direct effect on students' mind-wandering; (2) self-efficacy, trait anxiety, task-value, and mind-wandering had significant direct effects on students' online engagement; and (3) the frequency of students' mind-wandering mediated the relationship between self-efficacy and engagement and trait-anxiety and engagement. Our hypotheses and statistical validations are summarized in Table 5.

Hypothesis [1] on the negative direct effect of self-efficacy on students' mind-wandering and the direct positive effect on students' engagement was supported. Students' awareness about their judgments to be successful and their ability to actively monitor those judgments while distance learning, plays an influential role in students' frequency to mind-wander. As such, students in emergency remote distance learning contexts who had higher levels of self-efficacy mind-wandered less. More specifically, students who were able to consciously monitor their own judgments and beliefs of success in the present moment while learning remotely were less likely to engage in off-task thought. The results on the effect of self-efficacy and mind-wandering support the meta-awareness hypothesis, positing that decreased mind-wandering occurs when there is increased awareness and self-monitoring while performing a task [127]. Additionally, as students' self-efficacy about online learning increased, their engagement within the course significantly increased. The results of this study are therefore consistent with that of social cognitive behavioral theorists identifyng students' self-efficacy as a significant positive predictor promoting students' online engagement, while also documenting a negative significant association with students' mind-wandering as a result of learners exhibiting increased meta-awareness [8,127,140,159].

Table 5
The Hypotheses of the study findings.

Hypotheses	Rejection Status	Statistical Validations
[H1] : Students' self-efficacy will have a direct negative effect on students' mind-wandering and will have a direct positive effect on students' engagement.	Fail to reject	$\beta = -.40, p < .001; \beta = .536, p < .001$
[H2] : Students' trait anxiety will have a direct positive effect on students' mind-wandering and will have a direct negative effect on students' engagement.	Fail to reject	$\beta = -.445, p < .001; \beta = -.073, p < .001$
[H3] : Students' task-value will have a direct negative effect on students' mind-wandering and will have a direct positive effect on students' engagement.	Reject; Fail to reject	$\beta = .064, p > .05; \beta = .321, p < .001$
[H4] : Students' mind-wandering will have a direct negative effect on students' engagement.	Fail to reject	$\beta = -.149, p < .001$
[H5A] : Students' self-efficacy will have an indirect positive effect on students' engagement.	Fail to reject	$\beta = .036, p < .001$
[H5B] : Students' trait-anxiety will have an indirect negative effect on students' engagement.	Fail to reject	$\beta = .066, p < .001$
[H5C] : Students' task value will have an indirect positive effect on students' engagement.	Reject	$\beta = -.009, p > .05$

Hypothesis [2] was confirmed, as the direct effect of students' trait anxiety on their degree of mind-wandering and the direct negative effect on students' engagement was statistically significant. Under these current learning conditions, individuals are likely experiencing greater levels of anxiety as the learning conditions, modalities, and external commitments have changed when compared to in-person learning [54, 133]. According to the executive failure hypothesis, the failure of executive control to regulate cognitive resources, such as combating distracting worries while learning remotely, can lead to mind-wandering as well as poor task engagement [62,88,112,131]. The persistence of negative thoughts has been shown to disrupt performance, as feelings of worry take up limited cognitive resources in the working memory that are often in high demand while learning [10,36,161]. In the pandemic context, Mesghina et al. [89] found undergraduates higher in COVID-19 distress and saw lower learning gains due to increased mind-wandering during the online lecture. Students' trait anxiety levels were also positively related to mind wandering, again lending some support to the executive failure hypothesis. Moreover, Hapsari [54] identified other contributing factors related to distance learning, such as unstable internet connection, technology device malfunctions, and lack of opportunities for students to actively participate. These results reflect that of the literature, indicating that high levels of anxiety are associated with lower levels of course engagement [19,157].

Interestingly, Hypothesis [3] was partially rejected, where the negative direct effect of students' task-value on mind-wandering was not significant. However, the positive direct effect of students' task-value on students' engagement was significant. While the literature shows that students with high levels of task-value should exhibit more active involvement within the course [8,34,109], the results of this study found that students' task-value beliefs did not significantly impact students' frequency to mind-wander. Drawing on the current concerns hypothesis, theorists suggest that mind-wandering is the result of the decrease in reward for participating in a task while increasing the reward of another [78]. One possible explanation for this inconclusive result is to consider the four components of task-value: attainment value, intrinsic value, extrinsic utility value, and cost. The former three components are comprised of factors that positively influence students' motivational factors [8,65,119]. However, the cost of participation is a less explored factor of task-value construct which invokes a negative valence of task participation, while attainment, intrinsic, and extrinsic value represents a positive valence [8,33].

On the other hand, as students' perceived interests, importance, usefulness, and "worthwhileness" when participating in the online learning course increases, so does their active engagement. Past research has found that when students participate in learning activities that actively develop such value components, students are more likely to develop and solidify their involvement in the course [20,65]. Increased learner involvement may serve as a powerful motivator, as high task-value beliefs are likely to lead to more learner participation, interaction, and engagement throughout the learning process [107]. Johnson et al. [64] further asserted that the conceptual underpinning between task engagement and perceived instrumentality while learning is the personal incentivized value of success. This is important during emergency remote distance learning where undergraduates have reported low levels of motivation and engagement in online courses [21, 57,133]. Consequently, although task-value did not predict students' mind-wandering, the four dimensions that make up student task-value beliefs as a motivational construct may help to further explain students' engagement in the emergency remote distance learning contexts.

Meanwhile, students' mind-wandering had a significant negative direct effect on students' online engagement, confirming Hypothesis [4]. As students' frequency of mind-wandering increased, students were less likely to be engaged in the course through active participation, on-task performance, or effortful involvement. One potential explanation is the distinct difference between emergency remote distance learning and online learning grounded in pedagogical learning design [57]. Pedagogical instructional design principles were likely overlooked in favor of deploying a means to facilitate teaching and learning quickly. Research on the efficacy of online learning models has shown that courses developed in conjunction with learning design principles take advantage of the affordances of educational technologies through enhanced digital interactivity, active instructor-student presence through coaching and scaffolding, and exploration through multimodal student-centered instruction, to name a few [21,95,98]. As task-unrelated mind-wandering is more likely to occur during monotonous environments [32] or long cognitively undemanding tasks [130], instructor-centered Zoom learning without opportunities for student-centered active learning opportunities such as cooperative learning and peer discussions may have exacerbated the quality of remote learning contexts [94], further explaining the negative effects between mind-wandering and course engagement. Szpunar and colleagues [139] argue, when comparing those being lectured to that of the lecturer, if the lecture is extremely engaging for the lecturer, but less so for those being lectured, this difference in perspective further perpetuates students' mind-wandering. As such, to reduce the extent to which students' mind-wander in online courses, designing online instruction to shift from passive monotonous instructor-centered teaching to active opportunities for student-centered learning is likely to reduce the occurrence of mind-wandering and foster engagement [139].

Hypothesis [5A] was accepted as this study found that students' mind-wandering mediated the relationship between self-efficacy and online engagement. There is broad support for students' self-efficacy as a strong and significant predictor of engagement in online courses [82, 105,142]. However, there is much less research exploring how the effects of mind-wandering might mediate this relationship. Consequently, this significant mediating pathway indicated that students' self-efficacy positively influenced students' online engagement, when factoring in lower levels of students' mind-wandering. As Bandura [159] states, "the act of regulating one's own motivations, thought processes, and affective states directly influence cognitive and behavioral actions within a learning environment" (p. 14). Furthermore, as self-efficacy facilitates positive self-appraisals, students with higher self-efficacy are more resilient and willing to persevere in more challenging situations. This critical meta-awareness of their ability to succeed and persevere in difficult tasks may deter instances of off-task thoughts, thereby mitigating the onset of mind-wandering and increasing course engagement.

The significant indirect effect of students' trait anxiety and online engagement confirmed Hypothesis [5B]. This significant indirect pathway indicates that students' trait anxiety negatively predicts students' online engagement, when factoring in the degree to which students' mind-wander. While Mesghina et al. [89] found state mind-wandering as a significant mediator between state distress and learning, evidence from this study builds on their approach, showing mind-wandering as a significant mediator between trait-anxiety and students' general online engagement. One possible reason for these trends is that anxiety, specifically the worries component, takes up limited cognitive resources that are in high demand , likely influencing the degree to which students' mind-wander [67,129]. Additionally, the act of mind-wandering impacted by anxiety, be that task-related or task-unrelated, further occupies the working memory capacity and cognitively shifts students' thoughts away from the primary task at hand. Such disruption in awareness, in turn, constrains one's working memory capacity from internalizing new information, subsequently leading to poor engagement within an online course [28,31,113]. Such findings corroborate the executive failure hypothesis [88]. Thus, this study findings provide rich insights into the relationships between students' attention, motivations, anxiety, and online engagement during the remote learning at the beginning of the pandemic.

5.1. Limitations

Certainly, more research is warranted to further evaluate the limitations to and affordances for undergraduate emergency remote distance learning. This *in situ* survey analysis was the first iteration of a multi-year analysis identifying the social, cognitive, and motivational factors influencing students' mind-wandering and online engagement. While considerable efforts were made to recruit as many students as possible across two universities, our survey response rate of 29.8% was considered "reasonable." Survey response rates at 15% are considered low, while rates as low as 30% are reasonable, with response rates over 50% indicated as remarkably high [126]. We suspect that this might have been the case due to the fact that this study requires an hour of participant's time. Considering survey response rates as a potential source of bias is an important methodological factor as it contributes to the uncertainty to make generalizable findings [42]. However, to minimize potential demographic bias, a chi-square test was conducted to compare the demographics of the study participants to the research institutions and no statistically significant differences were found.

It is also important to note that the measured variables used in this study were completely self-reported. While validated survey constructs were deployed, self-report responses are based upon a students' perception that may be fluid at one specific point in time [136]. Self-report assessments might offer biased estimates of behavior, attitudes, and perceptions as a result of misunderstanding questions or prompts, overestimations of self-evaluations, and even social desirability to name a few [116]. As such, we acknowledge the inherent constraints associated with self-report measures. Future follow-up analysis might consider log analysis to more precisely capture students' online course engagement data such as time on task, rate of course participation, rate of assignment submissions, and course grades. Combining self-report with clickstream logged student achievement data may provide more global and rigorous reporting of students' course behaviors. Though we acknowledge survey research may introduce bias, this methodological approach affords the opportunity to examine a wider population of learner experiences.

Further, the survey questionnaires were deployed in two different waves, which indicates that the research participants may differ between groups due to the time variance of survey assessment. This was not accounted for in the present study, which may bias the study results. However, one of the primary goals of this study was to test a hypothesized model for factors influencing students' online engagement and the role of mind-wandering during the entire year long period higher education institutions were in remote instruction to provide generalizable findings. Nevertheless, the time factor is an important consideration as students' social, cognitive, and behavioral factors may have fluctuated as emergency remote learning continued. Future analysis will include nested model comparisons in SPSS AMOS. Conducting a multiple group analysis in structural equation modeling will afford the comparison of the same measurements between multiple population samples collected at different points in time [30]. This method will then allow the researchers to test the assumptions of whether the groups examined are equal by examining if the different sets of path coefficients are invariant [84]. Alternatively, we might also consider using fixed-effects modeling to test the relationship between the predictor and outcome variables varying over time. Controlling for the time-invariant characteristics affords researchers to test the net effect of the predicted outcome variables, as the assumption that time may be a biasing factor may be accounted for [141].

In lieu of the non-significant pathway found on task-value and mind-wandering Hypothesis [3 & 5C], we might also consider specific components of task-value in the future, as the positive and negative valances within the construct may be affecting student responses. Since the non-significant finding of task-value and mind-wandering was contradictory to our hypothesis, exploring the dimensional components of task-value such as cost or intrinsic value alone might provide more nuanced understandings of students' task-value beliefs. In addition, the current mind-wandering questionnaire did not distinguish between task-related or task-unrelated mind-wandering. Identifying these differences might better capture what students are thinking about while learning in such vastly different contexts.

5.2. Theoretical Implications

The present study demonstrated that students' mind-wandering partially mediated the relationship between students' self-efficacy and engagement as well as students' trait anxiety and engagement as typically experienced in their online Zoom courses. In addition, students' self-efficacy, trait anxiety, task-value, and mind-wandering were significant predictors of online engagement. Importantly, the results in this study are consistent with two of the three major hypothesized explanations for why students mind-wander: the executive failure and meta-awareness hypotheses. This study afforded the opportunity to test the competing theories of mind-wandering within students' typical Zoom learning contexts and during a critical period of teaching and learning. These findings also suggested pathways by which learners' may have maintained engagement and learning through Zoom. However, more research is needed to test students' task-value beliefs grounded within the current concerns hypothesis as a potential source of why students mind-wander. Nevertheless, our model supports the theoretical conclusions that suggest students who have high levels of self-efficacy are less susceptible to mind-wandering and more likely to be engaged in their courses. Moreover, the model also supports theories proposing that students' anxieties and worries predicted less effective regulation of cognitive resources, thereby predicting an increase in mind-wandering and a decrease in online engagement. As a result, students' self-efficacy and trait-anxiety predicted their level of engagement in an online Zoom class, and this relationship was mediated by their frequency to mind-wander.

5.3. Practical Implications

In light of these findings, we recommend practical implications for instructors and administrators drawn from evidence-based online pedagogical learning design frameworks that are aimed at reducing the frequency of student mind-wandering and increasing student course engagement in remote learning environments. A promising and emerging framework for online learning includes learning experience design (LXD). LXD is the process of creating learning environments to foster learning in a human-centered, goal-orientated method [4,27,41,154]. Floor [41] defines the five fundamentals of LXD as human-centered, goal-oriented, based upon a theory of learning, including learning through practice, and being heavily interdisciplinary. In each of these five facets, there is a major emphasis on empathy, focusing on the intended and unintended design outcomes for the learners [87]. Upon selecting an online pedagogical framework to implement, instructors might consider instances in which sources of self-efficacy, task-value beliefs, anxiety, mind-wandering, and engagement are accounted for within the design of the course.

Drawing on the theoretical perspectives of mind-wandering, instructors might consider instances in which students' self-efficacy can be promoted, such as providing feedback and providing sufficient source examples for students to develop confidence in their online learning capabilities [1,12,96,154]. This feedback may occur synchronously online with the use of real-time live polling that may aid in students' engagement and reduce instances of mind-wandering while learning [110]. This feedback might also occur asynchronously with weekly feedback provided by the instructional team on weekly assignments, assessments or projects [154]. Furthermore, by implementing a needs assessment or pre-course survey, the instructor might assess early on what students value and how students are feeling about the course. This not only encompasses a method to assess students' concerns and worries about the learning experience, but also allows novice instructors facilitating online teaching and learning a pathway to serving the students who stand to benefit the most. Additionally, assessing students' needs might allow instructors to determine the modality in which synchronous, asynchronous, or hybrid may be more beneficial to students learning. As Wong and Hughes [157] showed in their study, conducting a needs assessment early on aallowed the researchers to measure changes in leaners' attitudes, feelings, reactions, and behaviors over 10 instructional weeks. Moreover, instructors might consider the elimination or reduction of traditional rote memorization exams in favor of assessments measuring high-order thinking and reasoning [114], such as cross-functional group projects or a conceptual final essay. Blending formative and summative assessments has been shown to reduce learning anxiety [29]. Additionally, Wong et al. [156] found that learners writing physical notes instead of using smartphone photography to capture information during video recorded lectures mind-wandered less, which in turn led to higher retention and learning performance. Other course design features informed by the executive failure and meta-awareness hypotheses are embedded opportunities for metacognitive learning strategies such as time management, planning, monitoring, reflections, and mindfulness training [37,113,137,139].

6. Conclusion

Our study findings have shown that students' engagement, as reported during their typical Zoom classes, was explained in part by their motivations, anxiety, and mediated by mind-wandering. These results are important as it encourages instructors to better attend to factors that positively impact students' mind-wandering and online engagement. Moreover, these results add to our understanding of students' learning experiences during emergency remote distance learning, serving as the foundation for future experimental research iterations to implement online learning design principles based upon theory that minimizes mind-wandering and increases student engagement, while also supporting learners' anxieties and self-efficacy.

Dataset Access

Wong, Joseph [155], Zooming in or Zoning Out: Examining Undergraduate Online Learning Experiences with Zoom and the Role of Mind-Wandering, Dryad, Dataset, https://doi.org/10.7280/D1GT32

Declaration of Competing Interests

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.caeo.2022.100118.

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