MIND WANDERING AND ONLINE LEARNING: 
A LATENT VARIABLE ANALYSIS

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by

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 Thoughts drift in everyday life and in the classroom. The goal of this study was to investigate how often students reported off-task thinking while watching online lectures. These findings were related to working memory capacity, topic interest, and achievement goal orientations. Structural equation modeling was used to evaluate how all of these factors were related and predicted performance in the course.

In the presented findings, 126 participants completed three complex span tasks, answered a 2x2 goal orientation questionnaire, responded to eight mind-wandering probes while watching two online lectures, and rated interest in the lecture topics.

In the reported models, higher levels of mind wandering predicted lower levels of academic performance. Lower levels of working memory capacity predicted higher levels of mind wandering and lower levels of academic performance. Higher levels of topic interest predicted lower levels of mind wandering. Higher levels of mastery approach orientations (those who learn to master content) predicted higher levels of task-related interference. A novel mind wandering probe, thinking about or using another technology, accounted for 29% of off-task thinking. Implications of these findings and considerations for future research are discussed.
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CHAPTER I
INTRODUCTION

Attention is subject to shift from ongoing activities to unrelated thoughts (McVay & Kane, 2012b). Minds wander so much so that Killingsworth and Gilbert (2010) created an iPhone app to collect responses to the question: Are you thinking about something other than what you’re currently doing? and found that mind wandering occurred 46.7% of the time in a sample of 2,250 adults representing 88 countries. Further reports also indicated that mind wandering occurs during 30-50% of daily life (Levinson, Smallwood, & Davidson, 2012; McVay & Kane, 2012b). Wandering minds often lead to performance and accuracy errors on the primary activity, especially if the activity was demanding and required concentration (e.g., McVay & Kane, 2009; McVay & Kane, 2012b; Unsworth & McMillan, 2012). Given the propensity for the mind to wander and related performance deficits, investigating individual differences in mind wandering and the impact on performance seemed particularly relevant in an educational setting.

Rationale

With mind wandering occurrences interrupting nearly half of daily life, drifting away from immediate and relevant activities would inevitably interrupt attention in the classroom. Unsworth, Brewer, and Spillers (2012) evaluated mind wandering in labs and during a week-long diary of mind wandering. Of the self-reported and unprompted instances of mind wandering, 76% were related to educational settings; subjects reporting the most off-task thoughts during studying and in class. In labs, subjects with lesser attentional control were more likely to experience mind wandering in their daily lives.
Attentional control was a latent variable derived from three scores/observed variables: an antisaccade task, a flanker task, and a psychomotor vigilance task. In addition, the relation between attention control and SAT scores was fully mediated by mind wandering.

Further research by Lindquist and McLean (2011) extended reports of mind wandering during classroom experiences. Subjects responded to five probes of mind wandering during a 50-minute in-class lecture on daydreaming. To measure mind wandering, subjects noted Yes or No during the lecture as to whether they were daydreaming (e.g., I wonder what my friends are doing now?) at the exact moment they heard a beep. Subjects also reported interest in the lecture and amount of notes taken. Off-task thoughts frequency increased with younger students who took fewer note details and had less interest in the lecture. High rates in off-task thoughts also related to poorer course exam scores. The current study modified this design by asking subjects eight probed mind wandering responses across two, 13-minute trials. Subjects in the current study also completed complex span tasks, four measures of topic interest and an achievement goal orientation survey.

Risko, Anderson, Sarwal, Engelhardt, and Kingstone (2012) also explored mind wandering during lectures and reported the relationship between off-task thinking, performance, and time on task. Subjects watched a 60-minute video lecture alone (experiment one) or in a classroom/group (experiment two), reported mind wandering while watching the lectures and answered post-lecture quiz questions derived from content presented immediately before the mind wandering probes. In each experiment,
four mind wandering probes were used. Two probes were presented in the first half of the lecture, and two probes were presented in the second half of the lecture. Four total probes were used to limit interruptions during the lecture. Overall, higher levels of mind wandering were associated with lower performance. And mind wandering increased with time, as higher levels of mind wandering were reported on the second-half probes.

As Unsworth, Brewer, et al. (2012) and Lindquist and McLean (2011) provided evidence of mind wandering the traditional classroom context, technology use in the same setting can also contribute to distraction. Interactions with Facebook, laptop-use, and mobile devices during in-class lectures created deficits in academic performance (Fried, 2008; Junco, 2012; Lin & Bigenho, 2012; Wood et al., 2012). Additional, self-reported, heavy media multitaskers had difficulty filtering non-essential information and lower task-switching accuracy than non-multitasking counterparts; Ophira, Nassb, and Wagner (2009) proposed these multitaskers were also unaware of the determents of multitasking to attentional accuracy. Interactions with media and technology multitasking can distract and create deficits in performance (Hollis, 2012); as such, the current study expanded the existing set of off-task thinking probes to include: thinking about or using another technology. (ex) texting; checking Facebook. Adding a self-report for technology-based distractions was designed to analyze the frequency of this specific category of off-tasking thinking compared to non-technology probes.

**Purpose of the Study**

Given the research on mind wandering in a variety of contexts, steps to advance mind wandering research forward should be taken at the intersection of these findings:
online education. This study evaluated individual differences in mind wandering while subjects watch video lectures in an online course and analyzed how these factors influenced academic performance. Individual differences in mind wandering, working memory capacity (WMC), interest, and motivation were considered. The hypothesis was that subjects with lower working memory capacity would experience higher levels of mind wandering and report lower levels of interest, all predicting lower levels of academic performance.

**Clarification of Terms**

**Academic performance**—Academic performance was determined by total points in the course and two quiz scores recorded immediately following video 1 and video 2.

**Interest**—Interest was evaluated using an adaptation of the domain-specific question Unsworth and McMillan (2012) utilized to measure interest. In the current study, subjects were asked, *How interested are you in Public Relations?* and *How interested are you in Advertising?* before and after video 1 and video 2 respectively. Novel to this study, interest was measured before and after each video. See Appendix B.

**Mind wandering**—Daydreaming, zoning out, and considering personal feelings or plans that distract from a primary task all constitute mind wandering (McVay & Kane, 2012b). There was discrepancy among *Task-Related Interference (TRI)*, defined below, and the defined instances of mind wandering. Mrazek and Smallwood (2012) considered any off-task thought to be mind wandering. McVay and Kane (2012b) stated,

> We do not consider all instances of attention to internal representations to be a reflection of mind wandering, however. For example, deliberate retrieval from
long-term memory (LTM), or generating imagery as a part of an ongoing task, do
not qualify as mind wandering because they represent task-relevant cognitions. (p.
304)

In this study, thought probes 3–7 were coded as task-unrelated thoughts, as reported in
McVay and Kane (2012b) and Unsworth and McMillan (2012). See Appendix A.

**Motivation**—Motivation was evaluated using the 2 x 2 Achievement Goal
Framework questionnaire (see Elliot, 1999; Elliot & McGregor, 2001). See Appendix C.

**Task-Related Interference (TRI)**—Personal evaluations or elaborations on the
current activity were considered to be task-related interference, where attention shifted
from the ongoing task to a related thought. McVay and Kane (2009) defined a TRI as an
“ambiguous intermediary between on- and off-task thought” (p. 200). Prompts such as, *I
thought about how I should work more carefully* or *I thought about the level of my ability*
(Smallwood, Fishman, & Schooler, 2007) measured TRI. In the current study, TRI was
measured as responses to the thought probe *(2) How well I’m understanding the video,* as
reported in McVay and Kane (2012b) and Unsworth and McMillan (2012).

**Task Unrelated Thought (TUT)**—Task unrelated thoughts (TUTs) is a term
used interchangeably with mind wandering. One who experiences TUTs is mind
wandering. Task unrelated thoughts occur when focus is unintentionally lost despite
efforts to concentrate and can lead to performance errors (Kane & McVay, 2012).

**Thought probes**—Mind wandering research utilized *thought probes* or brief
interruptions to the ongoing activity that asked subjects to categorize preceding thoughts
as on-task or off-task (McVay & Kane, 2012b). Thought probes were adapted from
previous applications in reading comprehension studies. Thought probes (3) *A memory from the past*; (4) *Something in the future*; (5) *Current state of being*; (7) *Other* were replicated from previous mind wandering studies (McVay & Kane, 2012b; Unsworth & McMillan, 2012). TUT probe (6) *Thinking about or using another technology.* (ex) texting; checking Facebook was novel to this study.

Thought probes are subjective, self-report measures. However, these reports were validated against objective measures of mind wandering (McVay & Kane, 2012a). Typically, the objective measure of mind wandering involved error rates and response times attributed to mind wandering during *Sustained Attention to Response Tasks* (SART), in which subjects inhibited responses to an infrequent target while responding to thought probes. Too slow or too fast (autopilot) response times indicated off-task focus (Smallwood, Fishman, et al., 2007). Errors in SART were also associated with goal neglect (McVay & Kane, 2009, 2010). SART trails were considered objective measures as subjects were unaware of response time variability and how this factor influenced reports of task-unrelated thoughts (Kane & McVay, 2012; McVay & Kane, 2012b). Given the validity of self-reports to thought probes as mind wandering, SART measures were not necessary and not included in this study.

**Working Memory and Working Memory Capacity (WMC)**—Working memory (WM) refers to attention used to maintain a goal and suppress unrelated information (Engle, 2002; McVay & Kane, 2010; Was, 2007). Working Memory Capacity (WMC) was the amount of attentional control. WMC was evaluated using three complex span tasks (reading, operational and spatial). All WMC measures were
collected via desktop downloaded applications authored in Revolution LiveCode with a MySQL database backend on the university server.

**Research Question**

What are the relationships among interest, motivation, working memory capacity, mind wandering, and academic performance?
CHAPTER II
REVIEW OF THE LITERATURE

Introduction Summary

The current study investigated off-task thinking in a completely online course. Subjects completed complex span tasks to evaluate working memory capacity, responded to thought probes while watching two online videos, rated topic interest before and after watching the presented materials, and answered questions related to achievement goal orientations. The relationships among these variables were compared to academic performance to expand the existing literature on mind wandering and performance to the online classroom context.

Literature Overview

People with lower working memory capacity (WMC) were more likely to experience distractions and task-unrelated thoughts during demanding tasks than those with higher WMC (e.g., Kane & McVay, 2012; Smallwood & Schooler, 2006). Mind wandering was typically measured subjectively by self-reports of task-unrelated thoughts in daily lives or self-reports to thought probes to on-off task thinking. Objective measures of mind wandering were commonly measured by error rates and varying response times in Sustained Attention Response (SART) lab trails. During SART trials, subjects with long pauses or fast, auto-pilot responses during a habitual response tasks were considered to be mind wandering. Working memory in mind wandering tasks was commonly measured with a latent variable derived from operation, reading and spatial complex span tasks. Other factors, such as mood, state of being, motivation, and interest
also influenced mind wandering and performance (e.g., McVay & Kane, 2010; Sayette, Reichle, & Schooler, 2009; Smallwood, Fitzgerald, Miles, & Phillips, 2009; Smallwood, O’Connor, Sudbery, & Obonsawin, 2007; Unsworth & McMillan, 2012).

**Mind Wandering and Working Memory**

The relationship between working memory capacity and mind wandering has long been researched due to the principle that those with a higher working memory capacity were less prone to distraction (mind wandering) during a demanding task. Working memory refers to attentional control used to maintain a goal and avoid distraction; greater working memory capacity means greater attentional capacity used to avoid distraction and maintain a goal (Engle, 2002; McVay & Kane, 2010; Was, 2007). Subjects who performed poorly on WMC tasks were unable to maintain task goals and therefore experienced more goal-neglect errors (McVay & Kane, 2010). WMC predicted performance on higher-order cognitive tasks, such as reading comprehension tasks and general fluid intelligence tests (Engle, 2002). Complex span tasks used to measure WMC were related to goal maintenance and competition resolution. These characteristics of assessment lend to evaluating individual differences in mind wandering, as both referred to mechanisms that keep access to a primary goal intact when faced with distracting or irrelevant information (McVay & Kane, 2010).

In order to evaluate WMC in mind wandering studies, McVay and Kane (2010) proposed that a latent WMC construct across operation span, reading span, and spatial span tasks would help reduce task-specific errors and provide a more generalized measure of WMC. For instance, if an individual was particularly strong in reading,
average in mathematics, and poor in spatial cognitive abilities, a latent construct among all of these observed variables (scores on span tasks) would define the common underlying factor among the three tasks, the individual’s working memory capacity. Complex span tasks were used to evaluate WMC in all reviewed empirical research regarding mind wandering.

Mrazek et al. (2012) evaluated if WMC tests were confounded by mind wandering; that is, if mind wandering during WMC tests diminished results on those measures. They also evaluated mind-wandering correlations to WMC, general aptitude, and SAT scores. In the first experiment, subjects were probed for on-task or off-task thoughts (ranging from 1 = completely on-task to 5 = completely on unrelated concerns) at unpredictable intervals while completing OSPAN, RSPAN, and SSPAN tasks.

Performance on individual tasks and across tasks was negatively related with the number of mind wandering instances, meaning subjects with lower working memory capacity had greater instances of off-task thoughts. Results were replicated in a second study; additional measurements of anxiety and task-related interference were not related to WMC. In a third study, half of the participants were promised financial incentives to increase performance on the OSPAN task.

The same negative correlation between mind wandering and WMC was reported. However, those who received financial incentives were less likely to mind wander than those without incentives and thereby improve performance on the OSPAN task; in this regard, it seemed that mind wandering disrupted performance on working memory tasks. In the final study, subjects received thought probes during a Raven’s Progressive
Matrices test and an OPSAN task; those results were related to the predictability of SAT scores to investigate the generality of TUTs disrupting performance. Mind wandering was negatively related to WMC and gF performance. Mind wandering during these lab studies was also predictive of SAT scores; nearly half of the shared variance among WMC, gF and SAT scores was accounted for by mind wandering.

**What Causes Mind Wandering?**

Working memory capacity was commonly considered a correlate in mind wandering studies; however, two prominent theories on what caused mind wandering (executive control and executive resources) constituted two conflicting frameworks. Kane and McVay (2012) proposed that mind wandering occurs more frequently for those with lesser WM capacity due to lesser executive-functioning control. When task demands were high, executive control processes were needed to inhibit off-task thoughts. When task demands were low (e.g., during a practiced or automated task) the specific task goal does not need regulated; mind wandering and an abstract understanding of the primary task were allowed (McVay & Kane, 2010).

Alternatively, Smallwood and Schooler (2006) attributed mind wandering to a decoupling or resource-dependent framework, where executive control became disengaged with the primary task and executive resources were directed to mind wandering; “mind wandering competes with the primary task for the control and coordination of working memory resources” (p. 950). In the resource-decoupling framework, mind wandering was more frequent during a practiced item, because executive resources were not exhausted in the primary task (Smallwood, O’Connor, et al.,
2007). For instance, Smallwood, O’Connor, et al. (2007) illustrated that subjects dealing with depression were more likely to mind wander as attention shifted away from the primary task to personal feelings, and these personal feelings demanded and monopolized executive functions—leaving less capacity to focus on the primary task. Conversely, high-demand activities produced less mind wandering as executive resources were instead dedicated to the ongoing task demands.

Analysis in task demand and its impact on mind wandering was a central component of the competing views of executive control and executive resources. In a recent study by Levinson et al. (2012), subjects completed low-perceptual-load visual search tasks and breath-awareness tasks both designed for minimal demands on WMC. Mind wandering was measured through probed responses and self-reports during visual search and breath-awareness tasks. Subjects with higher WM capacity were more likely to mind wander. Levinson et al. proposed this finding supports the model that working memory resources were utilized in maintaining task-unrelated thoughts; that this data did not fit into a model of executive control-failure, where subjects who were better at restricting attention mind wandered more.

The effects of alcohol on mind wandering also received critical analysis from the view of executive control compared to executive resources perspectives. Alcohol/inebriated and placebo groups were established to investigate the capacity for meta-awareness of mind wandering (Sayette et al., 2009). After receiving the treatment (placebo or alcohol), both groups were probed for mind wandering instances and facilitated with the means to self-report mind wandering while reading War and Peace.
The alcohol group was more than twice as likely to be caught mind wandering by probes than the placebo group; however, the alcohol group self-reported meta-awareness of mind wandering at the same rate as the placebo group. Kane and McVay (2010) argued that the Smallwood mind wandering/executive resources model does not fit the findings in alcohol consumption and mind wandering. TUTs should diminish with inebriation in a resource-dependent framework as executive resources were fatigued and depleted. However, executive control failures accounted for increased mind wandering during inebriation, which was the case.

Another study heavily debated from both executive control and executive resources frameworks involved neural recruitment of executive functions during mind wandering. fMRI scans were conducted while subjects performed SART tasks and received mind wandering probes with on-off task awareness probes (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009). Scans indicated mind wandering associations with the executive networks of the brain used for executive resources during off-task thoughts. In addition, this “neural recruitment” (p. 8720) of executive resources was most pronounced when subjects lacked meta-awareness of their own mind wandering. On-task episodes relied on the default neural network. Self-reported mind wandering to probes (subjective) and error-rates on SART tasks (objective) activated the same neural networks during mind wandering, thus suggesting validity of both mind wandering measures.
Although the neural recruitment of executive systems of the brain during mind wandering supports a resource-demanding view of executive functioning (Christoff et al., 2009), Kane and McVay (2010) argued:

If generating and maintaining mind-wandering episodes requires executive resources, then those resources should be used regardless of whether there is a competing primary task: executive-control structures should be especially, and similarly, active during restful thought and during TUTs. If, however, executive-control areas are only active in service of redirecting thoughts back toward the task, they should be active only during TUTs and not during unconstrained thought or rest. (p. 194)

So arguments were made to fit the neural recruitment of executive in both frameworks of executive control and resource-demand.

In the current study, it is hypothesized that mind wandering occurred due to a lack of executive control while watching the two online videos. Therefore, it was implied that subjects who reported mind wandering experienced lapses in executive control in the primary task (video watching).

**Labs and Daily Life**

In order to capture mind-wandering instances in daily lives, Kane et al. (2007) asked subjects to complete lab-based span tasks to measure WMC and respond to on-off task prompts in their daily lives via Palm Pilot personal digital assistant (PDA) signals. Thoughts wandered more when subjects were tired, stressed, in stimulating environments, bored, or while engaged in unpleasant activities, such as homework.
Concentration, happiness, and task enjoyment decreased mind wandering. Demanding tasks also reduced mind wandering. At highest levels of concentration, high-WMC subjects mind wandered less, “focused almost perfectly on the task” (p. 618). At lowest levels of concentration, high-WMC subjects mind wandered more than low-WMC subjects. Regardless of WMC, minds wandered more when bored, stressed and disinterested.

Unsworth, McMillan, Brewer, and Spillers (2012) collected unprompted instances of mind wandering in a week-long diary and lab experiments. Of the self-reported daily attentional failures, the greatest instances of mind wandering occurred while studying and in class—this accounted for 76% of the self-reported task unrelated thoughts, and these classifications were negatively related to WMC, attentional control (assessed in labs via Antisaccade, Flanker and Psychomotor vigilance tasks) and SAT scores; meaning those who reported mind wandered in educational settings had less working memory capacity, attentional control, and lower SAT scores. Overall, the relation between AC and SAT scores was fully mediated by mind wandering in everyday lives and the relation between WM and SAT was partially mediated by AC and mind wandering.

Unsworth, Brewer, et al. (2012) researched everyday cognitive failures (distraction, absent-mindedness, mind wandering, retrospective and prospective memory failures) and their relationship with measures of cognition and SAT scores. Subjects noted failures in retrospective memory (forgetting), prospective memory (failing to carry out an intention), and attention (distraction, absent-mindedness, mind wandering) during a week-long diary report. Subjects also completed a series of lab-based WMC,
attention-control, and memory tasks. Lab results predicted everyday cognitive failures. Individuals with low WMC and low AC were more likely to experience mind wandering, especially during high distraction. The total number of reported memory and attention failures were related. Everyday cognitive failures were related to SAT scores; everyday mind wandering/attention failures had the strongest negative correlation with SAT scores.

**Interest and Motivation**

**Interest.** Benefits of interest and learning have long been studied. Schiefele and Krapp (1996) noted that in 30 years of research, it is well documented that topic interest and learning from text were significantly related. In their study, subjects interested in the text experienced increases in free recall and also increases in elaborative propositions and main ideas, which indicates in increased depth of learning. An association between interest and online video may share a similar relationship to merit the investigation in the present study.

Unsworth and McMillan (2012) examined individual differences in mind wandering, WMC, interest, motivation, topic experience, and their relationship with reading comprehension. Subjects completed OSPAN, RSPAN, and SSPAN tasks, read the half of one textbook chapter, and received six mind-wandering probes during the reading task. Subjects then completed a reading comprehension test. Following the comprehension test, subjects answered two questions on interest (*How interested were you in the topic of the text?* and *How interested are you in this topic in general?*), two questions on motivation (*How motivated were you to do well on the task?* and *How much did your overall motivation influence your performance on the test*?), and three questions
on prior knowledge. Subjects with low WMC reported more mind wandering while reading than those with high WMC. Less interested and less motivated subjects mind wandered more than interested, motivated subjects. Motivation mediated the relationship between interest and mind wandering—individuals who were not interested were also not motivated and had higher rates of MW. WMC was unrelated to interest and motivation.

Although significant findings were associated with motivation and mind wandering in the Unsworth and McMillan (2012) study, the motivational questions themselves were limited to the task and performance, which could limit the scope of the findings. Kane and McVay (2012) reviewed mind-wandering findings and noted an association between TUTs and WMC capacity was only related on cognitive-demand and not motivational variables (e.g., boredom, task enjoyment, happiness). Given the discrepancy of the influence of motivation on mind wandering and performance, a more throughout investigation into this individual difference was needed.

Motivation. When researching the mind of a learner and academic performance, consideration to motivation seemed paramount. The relationship between motivation and academic performance has long been researched and analyzed making it a relevant variable to be considered while exploring individual differences in an educational setting.

In terms of generalized motivation framework, Elliot, McGregor, and Gable (1999) investigated the relationship among achievement goals and exam performance. Subjects answered motivation-based questionnaires related to exam preparation; these answers were examined against exam performance. Elliot et al. proposed a trichotomous achievement goal framework that highlighted mastery-approach goals, performance-
approach goals, and performance-avoidance goals. Mastery-approach goals were based on the need for achievement and task mastery. Performance approach goals were also based on a need for achievement, but motivation was more dependent on extrinsic successes. For example, a mastery-approach student studied to master the content as a life goal; a performance-approach student studied to get an A on the test. Performance-avoidance goals were based on a fear of failure. In the study, mastery-approach goals were unrelated to exam performance but positively related to deep-processing study strategies. Performance-approach goals were positively related exam performance with no relationship to a particular study strategy. Performance-avoidance goals were negatively related to exam performance and positively related to surface-level and disorganized study strategies.

Although including a mastery-avoidance dynamic to the model seemed “counterintuitive” (p. 181) as mastery goals are often associated with desirable traits in a motivated learner, Elliot (1999) included a mastery-avoidance goal construct “to account for the broad spectrum of competence-based strivings” (p. 181) and proposed a 2x2 achievement model. Elliot illustrated that mastery goals represent individuals who are engaged in mastery but focus on the negative possibility of evaluation. For illustration, Elliot explained that a professional basketball player in the twilight of his career might develop the mastery-avoidant goal not to fall short of a past all-star performance. In an educational setting, a mastery-avoidant learner may approach a scenario with intentions of mastering course materials but also be concerned with failing to comprehend the materials.
Elliott, Murayama, and Pekrun (2011) argued that within mastery and performance goal constructs lies consideration for the task, self, and others, and these goal-orientations may be complex enough to justify separate constructs. As such, they revised the 2x2 achievement model (see Elliot, 1999) and proposed a 3x2 model of achievement. The new model reconfigured the underpinnings of the mastery-performance framework by introducing six new constructs based on task, self and other orientations:

- **task approach** (*do the task correctly*)
- **task-avoidance** (*avoid doing the task incorrectly*)
- **self-approach** (*do better than before*)
- **self-avoidance** (*avoid doing worse than before*)
- **other-approach** (*do better than others*)
- **other-avoidance** (*avoid doing worse than others*) (p. 634).

Task-based goals were related to performance on the task itself. Self-based goals were related past or future performance. And other-based goals were defined in performance compared to others. Elliot et al. (2011) measured temperament, achievement goals, exam performance, intrinsic motivation, learning efficiency, worry about exams, absorption in class, energy in class, and SAT scores and presented that a 3x2 achievement model for motivation was a better fit for goal orientation than 10 alternative models, including the former 2x2 and trichotomous model.

Although Elliot (2011) presented that a 3x2 achievement model provided a better fit than a 2x2 achievement model in aligning goal orientations, it can be argued that the newer 3x2 model has a limited application compared to the 2x2 model that has been...
vetted in over a decade of empirical research. In addition, reconciling categories of motivation in mind wandering research may produce stronger associations in terms of mastery and performance based orientations rather than task, self and other. Given the depth and breadth of research and the fit of motivational variables, the 2x2 achievement goal framework was utilized to measure motivation in the proposed study.

**Summary**

Mind wandering occurs nearly half of our everyday lives. Individuals with high WMC mind wander less and perform better in demanding tasks. In less-demanding tasks, individuals with high WMC mind wander more than those with low WMC. Mind wandering is negatively related to general intelligence, task performance, and SAT scores. Individual differences in mood, interest, and motivation can also impact instances of off-task thinking.

In this study, the following research question was investigated: In the context of online learning, what are the relationships among interest, motivation, working memory capacity, mind wandering, and academic performance?

The hypothesis was that subjects with lower levels of working memory capacity will have lower levels of interest, higher levels of mind wandering, and lower levels of academic performance. Subjects with higher levels of performance avoidant and mastery avoidant goal orientations will have higher levels of mind wandering.
CHAPTER III

METHODS

Participants

A total of 153 undergraduates at a large Midwestern state university participated in the study and received extra course credit as compensation. Credit was allocated based on completion of the research tasks, not performance. Three participants did not complete 50% or more of the tasks making up latent factors in the study. One participant was an advanced-placement high school student (and potentially under the age of 18). These four participants were removed from the analysis. One participant was eliminated from the analysis due to accuracies of zero on one or more of the working memory span tasks. Eight participants experienced technical problems with a complex span task and submitted incomplete data; these incomplete sets were removed from the analysis.

After completing each span task, participants were asked if they wrote down any letters and how many letters they wrote down (to help complete the span task with greater accuracy). If a participant reported any letters or failed to answer the question, that span task was removed from the analysis. Maximum likelihood estimates of means and intercepts were used to complete missing span task data. Any subject missing more than one span task was eliminated from the study. The percent of total missing data was 4.76% in span task scores. In total, 126 subjects were included in the final analysis.
Materials and Procedure

2x2 Achievement Goal Framework Questionnaire

Participants completed the 2x2 Achievement Goal Framework questionnaire presented in Elliott and McGregor (2001). See Appendix C. The questionnaire was created in ColdFusion with a MySQL database and administered online.

Interest

All participants were asked an adapted version of the interest measures presented in Unsworth and McMillan (2012). Participants responded 1–5 to the following questions before and after video 1 and video 2:

*Video 1: How interested are you in Public Relations?*

5—Very Interested
4—Somewhat Interested
3—Neutral
2—Not Very Interested
1—Not at All Interested

*Video 2: How interested are you in Advertising?*

5—Very Interested
4—Somewhat Interested
3—Neutral
2—Not Very Interested
1—Not at All Interested
Complex Span Tasks

Participants downloaded and completed three complex span (RSPAN, OSPAN, and SSPAN) tasks modified from Bailey (2012). All WMC measures were collected via Mac and PC desktop applications authored in Revolution LiveCode. Data were stored in a MySQL database. WM span scores were calculated using partial-credit scoring (see Conway et al., 2005; Was, Rawson, Bailey, & Dunlosky, 2011).

In the RSPAN task, participants read a short sentence (e.g., “Karen spent the afternoon baking desks”) and had four seconds to decide whether the sentence made sense or not. In response to the sentence, participants responded yes (if the sentence made sense) or no (if the sentence did not make sense). After four seconds, a letter was presented on the screen for one second. Participants were encouraged to watch the letters closely and later recall as many as possible in the order they appeared. The RSPAN trial consisted of 15 trials and 75 total targets (letters) in 3–7 letter sets. All participants received the same sequence of trials, total letters, and letter sets.

In the OSPAN task, participants read a math problem (e.g., “Is \([3 \times 1] + 1 = 5\)?”) and had four seconds to report if the equation was incorrect or correct. After four seconds, a letter was presented on the screen for one second. Participants were encouraged to watch the letters closely and later recall all of the letters that followed the math problems in the order they appeared. Like the RPSAN task, the OSPAN trial consisted of 15 trials and 75 total targets (letters) in 3–7 letter sets. All participants received the same sequence of trials, total letters, and letter sets.
In the SSPAN task, participants were presented with a random display of dark blue circles, light blue circles, and dark blue squares in random positions on the screen. See Figure 1.

Figure 1. SSPAN single display.

For each display, participants were instructed to count the number of dark blue circles and memorize that number. Participants clicked the dark blue circles. When all dark blue circles were clicked, the screen advanced to the next display. Participants were encouraged not to count circles before clicking, pause, or take too long between clicks. As in the RSPAN and OSPAN trials, the SSPAN consisted of 15 trials and 75 total
targets (numbers) in 3–7 number sets. All participants received the same sequence of trials, total numbers, and number sets.

**Mind Wandering: Video 1 and Video 2**

Videos used in this study were actual course videos developed by Professor Gary Hanson and featured in a fully online course, Media, Power and Culture. Both videos were filmed in an HD studio with the same production setup. Video 1 was a 13:08 minute introduction to Public Relations. Video 2 was a 12:49 minute introduction to Advertising. Both videos featured Professor Hanson delivering the lecture directly to the camera. See Figure 2.

![Figure 2. Playback format for Video 1 and Video 2.](image)
Videos were streamed online. After starting the videos, participants could not pause, restart, or stop playback. Participants were informed that they would be asked questions throughout the video. They were encouraged to set aside 15 minutes and complete a video in one sitting. Participants were also informed that they would receive a quiz immediately after the video.

Mind-wandering probes were programmed to appear four times during playback. During a probe, the video stopped and a sound beeped to alert a prompt on the screen. After responding to the probe, the video automatically resumed playback. Interest was collected before and after each video. Following the last interest measure, participants answered a four-question quiz. After completing the quiz, participants were asked if they would like to rewatch the video or close the window and exit. See Table 1 for the video playback schedule. See Figure 3 for an example of the mind wandering probe on screen.

Table 1

Mind Wandering Probe Schedule: Video 1 and Video 2

<table>
<thead>
<tr>
<th>VIDEO 1</th>
<th>TUT1_1</th>
<th>TUT1_2</th>
<th>TUT1_3</th>
<th>TUT1_4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest1_1</td>
<td>Start Video</td>
<td>3:15 Mind Wandering Probe 1</td>
<td>6:30 Mind Wandering Probe 2</td>
<td>9:45 Mind Wandering Probe 3</td>
</tr>
<tr>
<td>End Video</td>
<td>Interest1_2</td>
<td>Quiz1</td>
<td>Rewatch Prompt</td>
<td></td>
</tr>
<tr>
<td>Pause</td>
<td>Pause</td>
<td>Pause</td>
<td>Pause</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIDEO 2</th>
<th>TUT2_1</th>
<th>TUT2_2</th>
<th>TUT2_3</th>
<th>TUT2_4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest2_1</td>
<td>Start Video</td>
<td>3:15 Mind Wandering Probe 1</td>
<td>6:30 Mind Wandering Probe 2</td>
<td>9:45 Mind Wandering Probe 3</td>
</tr>
<tr>
<td>End Video</td>
<td>Interest2_2</td>
<td>Quiz2</td>
<td>Rewatch Prompt</td>
<td></td>
</tr>
<tr>
<td>Pause</td>
<td>Pause</td>
<td>Pause</td>
<td>Pause</td>
<td></td>
</tr>
</tbody>
</table>
Figure 3. A mind wandering probe.

**Mind Wandering Probes**

While watching the video, participants received four mind wandering probes that asked them to classify thoughts in the last five seconds. Response 1 was evaluated as on-task. Response 2 was evaluated as TRI. Responses 3–7 were evaluated as TUTs. The same mind wandering probes were administered for both videos.

*Mind wandering probes:*

*In the last 5 seconds, what were you just thinking about?*

1. The video.

2. How well I’m understanding the video.

3. A memory from the past.
4. Something in the future.

5. Current state of being. (ex) I’m feeling hungry

6. Thinking about or using another technology. (ex) texting; checking Facebook.

7. Other.
CHAPTER IV

ANALYSIS OF THE FINDINGS

Descriptive Statistics

Table 2 displays the descriptive statistics for the 16 observed variables. RSPAN displays the partial-credit score on the reading complex span task; OSPAN, the operation span task; and SSPAN, the spatial span task.

TUT1 and TUT2 represent mean scores from 0–1 based on self-reported responses to four mind wandering probes on video 1 and video 2 respectively. Using the same analysis as previous research (McVay & Kane, 2012a; Unsworth & McMillan, 2012), response 1 (the video) was coded as on-task; response 2 (how well I’m understanding the video) was coded as task-related interference; responses 3–7 (off-task/task unrelated thoughts) were coded as task-unrelated thoughts (TUTs). The higher a TUT1 or TUT2 score, the more a subject experienced task unrelated thoughts.

Interest1 and Interest2 represent the sum of interest measures before and after video 1 and video 2. Higher scores represent greater levels of interest.

Quiz1 and Quiz 2 scores represent percent accurate across a four-item, multiple-choice quiz given immediately after video 1 and video 2. Total_Points indicate the total points earned in the course.

Performance_Appr, Performance_Avoid, Mastery_Appr, and Mastery_Avoid represent the sum of responses to the 2x2 Achievement Goal Framework Questionnaire by category. The questionnaire presented three questions for each category (Performance Approach, Performance Avoidance, Mastery Approach, Mastery Avoidance) on a
Table 2

**Descriptive Statistics of 16 Observed Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSPAN</td>
<td>.81</td>
<td>.16</td>
<td>.11 – 1</td>
</tr>
<tr>
<td>OSPAN</td>
<td>.77</td>
<td>.24</td>
<td>.03 – 1</td>
</tr>
<tr>
<td>SSPAN</td>
<td>.90</td>
<td>.14</td>
<td>.21 – 1</td>
</tr>
<tr>
<td>TUT1</td>
<td>.44</td>
<td>.27</td>
<td>0 – 1</td>
</tr>
<tr>
<td>TUT2</td>
<td>.42</td>
<td>.33</td>
<td>0 – 1</td>
</tr>
<tr>
<td>TRI1</td>
<td>.91</td>
<td>.97</td>
<td>0 – 4</td>
</tr>
<tr>
<td>TRI2</td>
<td>.70</td>
<td>.93</td>
<td>0 – 4</td>
</tr>
<tr>
<td>Interest1</td>
<td>6.62</td>
<td>1.75</td>
<td>2 – 10</td>
</tr>
<tr>
<td>Interest2</td>
<td>6.77</td>
<td>1.88</td>
<td>2 – 10</td>
</tr>
<tr>
<td>Quiz1</td>
<td>.74</td>
<td>.27</td>
<td>0 – 1</td>
</tr>
<tr>
<td>Quiz2</td>
<td>.78</td>
<td>.27</td>
<td>0 – 1</td>
</tr>
<tr>
<td>Total_Points</td>
<td>1257.9</td>
<td>285.51</td>
<td>78 – 1562</td>
</tr>
<tr>
<td>Perform_Appr</td>
<td>9.13</td>
<td>3.10</td>
<td>3 – 15</td>
</tr>
<tr>
<td>Perform_Avoid</td>
<td>11.41</td>
<td>3.01</td>
<td>3 – 15</td>
</tr>
<tr>
<td>Mastery_Appr</td>
<td>9.67</td>
<td>2.79</td>
<td>3 – 15</td>
</tr>
<tr>
<td>Mastery_Avoid</td>
<td>7.81</td>
<td>2.84</td>
<td>3 – 15</td>
</tr>
</tbody>
</table>

*Note.* RSPAN = reading span task; OSPAN = operation span task; SSPAN = spatial span task; TUT1 = task unrelated thought (video 1); TUT2 = task unrelated thought (video 2); TRI1 = sum of task-related interference on video1; TRI2 = sum of task-related interference on video2; Interest1 = sum of interest before and after (video 1); Interest2 = sum of interest before and after (video 2); Quiz1 = practice quiz (video1); Quiz2 = practice quiz (video 2); Total_Points = total points earned in the course; Perform_Appr = performance approach total; Perform_Avoid = performance avoidance total; Mastery_Appr = mastery approach total; Mastery_Avoid = mastery avoidance total.
five-point scale. Larger numbers represent stronger associations within a particular category of motivation/achievement goal.

TRI1 and TRI2 represent the sum of responses (how well I’m understanding the video) to the mind wandering probes across video1 and video2, respectively.

**TUT and Interest Scores Across Measures**

In terms of interest measured before and after watching videos 1 and 2, results of a paired-samples *t*-test indicated that there was no significant difference between Interest1 before \( (M = 3.34, SD = .87) \) and after \( (M = 3.28, SD = 1.00) \), \( t(125) = 1.05, p = .30 \). In addition, there was no significant difference between Interest2 before \( (M = 3.42, SD = .96) \) and after \( (M = 3.35, SD = 1.08) \), \( t(125) = 1.00, p = .32 \). See Table 3.

Suggesting mind wandering was consistent between video1 and video 2, a paired-samples *t*-test indicated that there was no significant difference between TUT1 \( (M = .44, SD = .27) \) and TUT2 \( (M = .42, SD = .33) \), \( t(125) = .99, p = .32 \). However, there was a significant difference between Task-Related Interference TRI1 \( (M = .91, SD = .97) \) and TRI2 \( (M = .70, SD = .93) \), \( t(125) = 2.37, p = .02 \). See Tables 4 and 5.
Table 3

*Paired-Samples T-Test for Interest1 (Before/After) and Interest2 (Before/After)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before</th>
<th>After</th>
<th>95% CI</th>
<th>Difference</th>
<th>r</th>
<th>t</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>n</td>
<td>r</td>
<td>t</td>
</tr>
<tr>
<td>Interest1</td>
<td>3.34</td>
<td>.87</td>
<td>3.28</td>
<td>1.00</td>
<td>126</td>
<td>-.056, .183</td>
<td>.75**</td>
</tr>
<tr>
<td>Interest2</td>
<td>3.42</td>
<td>.96</td>
<td>3.35</td>
<td>1.08</td>
<td>126</td>
<td>-.070, .213</td>
<td>.70**</td>
</tr>
</tbody>
</table>

** p < .01

Table 4

*Paired-Samples T-Test for TUT1 and TUT2*

<table>
<thead>
<tr>
<th>Variable</th>
<th>TUT1</th>
<th>TUT2</th>
<th>95% CI</th>
<th>Difference</th>
<th>r</th>
<th>t</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>n</td>
<td>r</td>
<td>t</td>
</tr>
<tr>
<td>TUT1 &amp; TUT2</td>
<td>.44</td>
<td>.27</td>
<td>.42</td>
<td>.33</td>
<td>126</td>
<td>-.026, .077</td>
<td>.55**</td>
</tr>
</tbody>
</table>

** p < .01

Table 5

*Paired-Samples T-Test for TRI1 and TRI2*

<table>
<thead>
<tr>
<th>Variable</th>
<th>TRI1</th>
<th>TRI2</th>
<th>95% CI</th>
<th>Difference</th>
<th>r</th>
<th>t</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>n</td>
<td>r</td>
<td>t</td>
</tr>
<tr>
<td>TRI1 &amp; TRI2</td>
<td>.97</td>
<td>.09</td>
<td>.93</td>
<td>.08</td>
<td>126</td>
<td>.035, .394</td>
<td>.43**</td>
</tr>
</tbody>
</table>

* p < .05

** p < .01

**Mind Wandering Frequencies**

Table 6 displays the frequencies of responses to mind wandering probes across both videos. Subjects reported on-task thinking 36.9% of the time, task-related
interference 20.1% of the time, and experienced off-task thinking 43.0% of time.

Technology-related thoughts represented the highest level of off-task thinking at 12.5%.

Table 6

Mind Wandering Frequencies (1008 Total Responses)

<table>
<thead>
<tr>
<th>In the last 5 seconds, what were you just thinking about?</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – The video.</td>
<td>372</td>
<td>36.9%</td>
</tr>
<tr>
<td>2 – How well I’m understanding the video.</td>
<td>203</td>
<td>20.1%</td>
</tr>
<tr>
<td>3 – A memory from the past.</td>
<td>48</td>
<td>4.8%</td>
</tr>
<tr>
<td>4 – Something in the future.</td>
<td>79</td>
<td>7.8%</td>
</tr>
<tr>
<td>5 – Current state of being. (ex) I’m feeling hungry.</td>
<td>95</td>
<td>9.4%</td>
</tr>
<tr>
<td>6 – Thinking about or using another technology. (ex) texting; checking Facebook.</td>
<td>126</td>
<td>12.5%</td>
</tr>
<tr>
<td>7 – Other.</td>
<td>85</td>
<td>8.4%</td>
</tr>
</tbody>
</table>

Correlations

Table 7 displays the correlations among the 16 observed variables.

Complex Span Tasks

Complex span tasks had moderate, positive correlations with one another: RSPAN and OSPAN ($r = .64, p < .01$); RSPAN and SSPAN ($r = .64, p < .01$); OSPAN and SSPAN ($r = .57, p < .01$). Each complex span task had a modest, positive correlation with academic performance variables with the exception of OSPAN with Quiz2 ($r = .16, p = .07$) and OSPAN with Total Points ($r = .15, p = .10$).
Table 7

*Correlations of the 16 Observed Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. RSPAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. OSPAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. SSPAN</td>
<td>.64**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. TUT1</td>
<td>-.13</td>
<td>-.18</td>
<td>-.25**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. TUT2</td>
<td>-.10</td>
<td>-.12</td>
<td>-.20*</td>
<td>.55**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. TRI1</td>
<td>-.02</td>
<td>.05</td>
<td>.04</td>
<td>-.51**</td>
<td>-.22*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. TRI2</td>
<td>-.07</td>
<td>-.04</td>
<td>-.11</td>
<td>-.19*</td>
<td>-.34**</td>
<td>.43**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Interest1</td>
<td>-.11</td>
<td>-.13</td>
<td>-.18*</td>
<td>-.27**</td>
<td>-.19*</td>
<td>.17</td>
<td>.22*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Interest2</td>
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<td>.12</td>
<td>.12</td>
<td>-.29**</td>
<td>-.39**</td>
<td>.20**</td>
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<td>10. Quiz1</td>
<td>.25**</td>
<td>.28**</td>
<td>.28**</td>
<td>-.28*</td>
<td>-.26**</td>
<td>.14</td>
<td>.06</td>
<td>.21*</td>
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<td>.17</td>
<td>.39**</td>
<td>-.21*</td>
<td>-.28**</td>
<td>-.06</td>
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<td>.19*</td>
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<td>-.03</td>
<td>.02</td>
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<td>-.09</td>
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<td>16. Mastery_Avoid</td>
<td>-.18*</td>
<td>-.13</td>
<td>-.16</td>
<td>.04</td>
<td>-.03</td>
<td>.04</td>
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<td>-.20*</td>
<td>-.02</td>
<td>.24**</td>
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** p < 0.01 level
* p < 0.05 level
**Mind Wandering (TUT1 and TUT2)**

TUT1 had modest, negative correlations with Quiz1 ($r = -.28, p < .01$), Quiz2 ($r = -.21, p = .02$), Interest1 ($r = -.27, p < .01$), Interest2 ($r = -.29, p < .01$), Mastery Approach ($r = -.25, p < .01$) and TRI2 ($r = -.20, p = .03$). TUT1 also had a moderate, positive correlation with TUT2 ($r = .55, p < .01$) and a moderate, negative correlation with TRI1 ($r = -.51, p < .01$).

TUT2 had modest, negative correlations with Quiz1 ($r = -.26, p < .01$), Quiz2 ($r = -.28, p < .01$), Interest1 ($r = -.19, p = .03$), TRI1 ($r = -.22, p = .02$), TRI2 ($r = -.34, p < .01$), Total Points ($r = -.24, p = .01$) and Mastery Approach ($r = -.33, p < .01$). TUT2 also had a moderate, negative correlation with Interest2 ($r = -.39, p < .01$).

**Achievement Goal Orientations**

Performance Approach had modest, positive correlations with Total Points ($r = .24, p = .01$) and Performance Avoidant ($r = .32, p < .01$).

Mastery Approach had modest, negative correlations with TUT1 ($r = -.25, p < .01$), TUT2 ($r = -.33, p < .01$). Mastery Approach also had modest, positive correlations with TRI1 ($r = .21, p = .02$), TRI2 ($r = .25, p < .01$), Interest1 ($r = .18, p = .04$) and Interest2 ($r = .26, p < .01$).

Mastery Avoidant had modest, negative correlations with RSPAN ($r = -.18, p = .05$) and Total Points ($r = -.20, p = .02$). Mastery Avoidant also had modest, positive correlations with TRI2 ($r = .21, p = .02$) and Performance Avoidant ($r = .24, p = .01$).
Task-Related Interference

TRI1 had a moderate, positive correlation with TRI2 ($r = .43, p < .01$) and modest, positive correlations with Interest1 ($r = .20, p = .03$) and Mastery Approach ($r = .21, p = .02$). TRI2 had modest, positive correlations with Mastery Approach ($r = .25, p < .01$) and Mastery Avoidant ($r = .21, p = .02$).

Academic Performance

Quiz1 had a moderate, positive correlation with Quiz2 ($r = .39, p < .01$). Both Quiz 1 ($r = .29, p < .01$) and Quiz2 ($r = .29, p < .01$) and modest, positive correlations with Total Points.

Achievement Goal Orientations – Reliability Statistics

The achievement goal orientation subsets were found to be highly reliable: Performance Approach (3 items; $\alpha = .85$); Performance Avoidant (3 items; $\alpha = .78$); Mastery Approach (3 items; $\alpha = .78$); Mastery Avoidant (3 items; $\alpha = .74$). High reliability (alpha above .70) indicated strong internal consistency within the instrument. Thus, items were scored similarly within achievement goal orientations.

Structural Equation Modeling

Structural equation modeling (SEM) is used to test hypothesized models that depict relationships among observed (measured) variables and latent (unmeasured) variables (Schumacker & Lomax, 2010). For instance, RSPAN, OSPAN, and SSPAN scores are observed, measured variables that constructed the latent variable: working memory capacity. The goal of SEM is to evaluate model fit, the degree to which the hypothesized model is supported by sample data (Schumacker & Lomax, 2010). There
are several fit indices used to determine model fit. In the reviewed literature good model
fit was consistently determined by reported chi-square, root mean square error of
approximation (RMSEA) and the comparative fit index (CFI).

Chi-square ($\chi^2$) evaluates the overall model fit and determines the difference
between the hypothesized model (the covariance matrices) and the sample data. As a
result, a significant chi-square value designates a significant difference in the
hypothesized model and the reported findings. The goal for a chi-square value, therefore,
is a non-significant result that indicates similarities between the model and the data. That
is why chi-square is often referred to as the “badness-of-fit” (Schumacker & Lomax,
2010, p. 86) measure. RMSEA is also used to evaluate how well the hypothesized model
fits the sample data. CFI is used to compare the hypothesized model with a null model,
in which all variables are not correlated (Hooper, Coughlan, & Mullen, 2008;
Schumacker & Lomax, 2010). In the reported structural equation models, appropriate
model fit was determined using rules of thumb for evaluating fit statistics reported in
previous findings: chi-square ($\chi^2$, p; $> .05$ or $\chi^2/df < 2$), CFI $\geq 0.90$ and RMSEA $\leq .08$
(Kline, 2011; McVay, Unsworth, McMillan, & Kane, 2013; Schumacker & Lomax,
2010; Unsworth & McMillan, 2012). The Sobel test was used to evaluate significance of
indirect effects. Models were conducted and analyzed using IBM AMOS.

**SEM: Working Memory Capacity, Mind Wandering, and Academic Performance**

The primary interest in the study was the relationship among working memory
capacity, mind wandering (TUTs), and academic performance. The hypothesized model
shown in Figure 4 provided a good fit to the data, $\chi^2 (17, N = 126) = 22.38, p = .137;$
Figure 4. Structural equation model predicting academic performance with mind wandering and working memory capacity. Boxes represent observed variables; circles represent latent variables. Arrows connecting latent variables represent standardized parameter estimates. All paths are significant at the .05 level. Error variance is not represented.

RMSEA = .055; CFI = .973. The estimated standardized direct effects of TUTs on academic performance were significant ($\beta = -.431, p < .01$). The estimated standardized direct effects of WMC on TUTs were significant ($\beta = -.266, p = .03$). The estimated standardized total effects of WMC on academic performance were $\beta = .524$; the direct effects were significant ($\beta = .409, p < .01$), and the indirect effects, via TUTs, were not significant ($\beta = .115, p = .09$).

**SEM: Topic Interest**

A second focus on this study examines influence of topic interest on mind wandering in the relationships among working memory capacity (WMC), mind
wandering, (TUTs) and academic performance. The hypothesized model shown in Figure 5 provided a good fit to the data, $\chi^2 (31, N = 126) = 48.41, p = .024; \chi^2/df = 1.56; \text{RMSEA} = .067; \text{CFI} = .938$. The estimated standardized direct effects of TUTs on academic performance were significant ($\beta = -.452, p < .01$). The estimated standardized direct effects of WMC on TUTs were significant ($\beta = -.265, p = .02$). The estimated

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**Figure 5.** Structural equation model predicting academic performance with mind wandering and working memory capacity with the effect of topic interest on mind wandering. Boxes represent observed variables; circles represent latent variables. Arrows connecting latent variables represent standardized parameter estimates. All paths are significant at the .05 level. Error variance is not represented.
standardized direct effects of topic interest on TUTs were significant ($\beta = -.66, p < .01$). The estimated standardized indirect effects of topic interest on academic performance, via TUTs, were significant ($\beta = .301, p = .03$). The estimated standardized total effects of WMC on academic performance were $\beta = .519$; the direct effects were significant, ($\beta = .399, p < .01$) and the indirect effects were not significant ($\beta = .120, p = .06$).

**SEM: Achievement Goal Orientations**

Unsworth and McMillan (2012) reported that motivation had a negative relationship with mind wandering and a positive relationship with topic interest. Unsworth and McMillan used two self-report questionnaire items to target motivation on the task and the influence of motivation on test performance. The present study explored the relationship between mind wandering and motivation in terms of achievement goal orientations.

The exploratory model shown in Figure 6 reported correlations among all goal orientations and predicted their respective estimated standardized direct effects on mind wandering (TUTs). This model provided adequate fit to the data, $\chi^2 (67, N = 126) = 128.43, p = .000; \chi^2/df = 1.92; \text{RMSEA} = .086; \text{CFI} = .899$. Mastery approach ($\beta = -.401, p = .01$) was the only significant parameter among direct paths from achievement goal orientations to TUTs. As such, mastery approach was the only achievement goal orientation considered in the subsequent stepwise models.

The model in Figure 7 predicted mind wandering with mastery approach and topic interest. The tested model provided good fit to the data, $\chi^2 (11, N = 126) = 14.26, p = .219; \text{RMSEA} = .049; \text{CFI} = .984$. This model indicated a significant direct effect of
topic interest on mastery approach ($\beta = .362, p = .02$). The estimated standardized total effects of topic interest on TUTs were $\beta = -.615$; the direct effects were significant ($\beta = -.532, p = .02$), and the indirect effects, via Mastery Approach, were not significant ($\beta = -.083, p = .17$). The estimated standardized direct effects of mastery approach on TUTs approached significance ($\beta = -.23, p = .088$).

To adjust and expand this model, Figure 8 predicted academic performance with mind wandering (TUTs) and working memory capacity (WMC) with the effect of topic interest and mastery approach on mind wandering. The tested model provided a good fit to the data, $\chi^2 (59 N = 126) = 80.39, p = .034$; $\chi^2/df = 1.36$; RMSEA = .054; CFI = .947. Total estimated standardized effects of TUTs and WMC on academic performance were nearly identical as Figure 5, and the total estimated standardized effects of mastery approach and topic interest on TUTs were nearly identical to Figure 7. The estimated standardized indirect effects of master approach on academic performance, via TUTs, were not significant ($\beta = .098, p = .15$). The estimated standardized indirect effects of topic interest on academic performance, via TUTs, were significant ($\beta = .255, p = .05$).
Figure 6. Exploratory structural equation model predicting the effect of achievement goal orientations on mind wandering. Boxes represent observed variables; circles represent latent variables. Curved lines represent correlations among achievement goal orientations. Arrows connecting latent variables represent standardized parameter estimates. Solid paths are significant at the .05 level. Dotted paths are not significant at the .05 level. Error variance is not represented.
Figure 7. Structural equation model predicting mind wandering with mastery approach and topic interest. Boxes represent observed variables; circles represent latent variables. Arrows connecting latent variables represent standardized parameter estimates. Solid paths are significant at the .05 level. Dotted paths are not significant at the .05 level. Error variance is not represented.
Figure 8. Structural equation model predicting academic performance with mind wandering and working memory capacity with effect of topic interest and mastery approach on mind wandering. Boxes represent observed variables; circles represent latent variables. Arrows connecting latent variables represent standardized parameter estimates. Solid paths are significant at the .05 level. Dotted paths are not significant at the .05 level. Error variance is not represented.
SEM: Task-Related Interference

Task-related interference represented “an ambiguous intermediary between on- and off-task thought” (McVay & Kane, 2009, p. 200), and this category of thought was not always analyzed in mind wandering research (e.g., Unsworth & McMillan, 2012). To further research in this area, this study explored the relationships among task-related interference in a stepwise series of exploratory structural equation models.

The exploratory model shown in Figure 9 reported correlations among all goal orientations and predicted their estimated standardized total effects on task-related interference (TRI). This model provided adequate fit to the data, $\chi^2 (67, N = 126) = 122.69, p = .000; \chi^2/df = 1.83; \text{RMSEA} = .082; \text{CFI} = .904$. As found in the achievement goals to mind wandering model, mastery approach ($\beta = .371, p = .03$) was the only significant parameter among direct paths from achievement goal orientations to task-related interference (TRI); therefore, mastery approach was the only goal orientation considered in the subsequent models.

The model in Figure 10 predicted task-related interference (TRI) with mastery approach and topic interest. This model provided a good fit to the data, $\chi^2 (11, N = 126) = 11.69, p = .387; \text{RMSEA} = .022; \text{CFI} = .996$. However, the only significant parameter was the direct path from topic interest to mastery approach ($\beta = .388, p = .02$).

To adjust and expand this model, Figure 11 predicted academic performance with task-related interference and working memory capacity with the effect of topic interest and mastery approach on task-related interference. This model provided a good fit to the data, $\chi^2 (60, N = 126) = 81.71, p = .033; \text{RMSEA} = .054; \text{CFI} = .937$. The estimated
standardized direct effects of interest on mastery approach were significant ($\beta = .405$, $p = .04$). The estimated standardized direct effects of mastery approach on task-related interference were significant ($\beta = .390$, $p = .02$). The estimated standardized direct effects of WMC on academic performance were significant ($\beta = .533$, $p < .01$). The estimated standardized direct effects of working memory capacity on task-related interference were not significant ($\beta = -.054$, $p = .65$). The estimated standardized direct effects of task-related interference on academic performance were not significant ($\beta = .137$, $p = .33$). There were no significant indirect effects in this model.
Figure 9. Exploratory structural equation model predicting the effect of achievement goal orientations on task-related interference. Boxes represent observed variables; circles represent latent variables. Curved lines represent correlations among achievement goal orientations. Arrows connecting latent variables represent standardized parameter estimates. Solid paths are significant at the .05 level. Dotted paths are not significant at the .05 level. Error variance is not represented.
Figure 10. Structural equation model predicting task-related interference with mastery approach and topic interest. Boxes represent observed variables; circles represent latent variables. Arrows connecting latent variables represent standardized parameter estimates. Solid paths are significant at the .05 level. Dotted paths are not significant at the .05 level. Error variance is not represented.
Figure 11. Structural equation model predicting academic performance with task-related interference and working memory capacity with the effect of topic interest and mastery approach on task-related interference. Boxes represent observed variables; circles represent latent variables. Arrows connecting latent variables represent standardized parameter estimates. All paths are significant at the .05 level. Dotted paths are not significant at the .05 level. Error variance is not represented.
CHAPTER V
DISCUSSION, LIMITATIONS, AND CONSIDERATIONS
FOR FUTURE RESEARCH
TUTs, WMC and Academic Performance

The current study replicated existing research by predicting the deficits in performance related to higher mind-wandering rates and extended the literature to the context of online learning, topic interest (in digital media), achievement goal orientations, real-world academic performance, and new considerations for task-related interference. At a baseline, the current findings were in line with previous findings in which working memory capacity modestly predicted mind wandering with correlations around -.20 or about 5% of the unique variance in self-reported TUTs (Kane & McVay, 2012); in the present study, the estimated standardized effects of working memory capacity on mind wandering ranged from $\beta = -.26$ to $\beta = -.29$ across models. Overall, higher rates of mind wandering were related to lower academic performance, lower working memory capacity, lower topic interest, and lower mastery approach goal orientations.

TUTs Across Times and Contexts

In terms of consistency across measures, there was no significant difference between topic interest before and after each video, and there was no significant difference in self-reported TUT rates across videos. The fact that interest remained the same before and after each video assured Professor Hanson (featured in the videos) that his lectures did not dash-away interest in public relations and advertising for 126 undergraduate students. No significant difference in TUT rates was consistent with previous findings.
and supported the claim that “whatever mechanisms are responsible for lapses of attention, then, they appear to be stable across people, tasks, contexts and time” (McVay & Kane, 2010, p. 326).

**TUT Frequencies**

Subjects reported on-task thinking 36.9% of the time, task-related interference 20.1% of the time, and experienced off-task thinking 43% of time, which was consistent with reported findings that individuals’ minds wander 30-50% of the time in daily life (Killingsworth & Gilbert, 2010; Levinson et al., 2012; McVay & Kane, 2012b). Subjects categorized probed responses in the provided categories 91.9% of the time, only responding other in 8.1% of all responses. With subjects mostly identifying thoughts with probed responses of thought, this result may support the argument made by McVay and Kane (2010) that probed responses are the “best and most objective” (p. 325) measure of mind wandering; subjects are able to respond to simple, categorical choices and minimize interruptions in the task itself, rather than negotiate rating-scaled responses. The information in probed self-reports may also be advantageous over a scaled response in terms of identifying the cause of distraction; for example, this study introduced a new off-task probe, *thinking about or using another technology*. (ex) texting; checking Facebook. These technology-related thoughts represented the highest level of off-task thinking; 29.1% of off-task thoughts were *thinking about or using another technology*, which represented 12.5% of all responses. As a result, including this probe should be considered in future mind-wandering research and inform treatments designed to reduce mind-wandering behaviors.
Structural Equation Modeling

The structural equation model of most critical focus and importance, illustrated in Figure 4, replicated previous research with nearly equal estimated standardized effects of working memory capacity on mind wandering and estimated standardized effects of working memory capacity on performance (Kane & McVay, 2012; McVay & Kane, 2012a, 2012b; Unsworth & McMillan, 2012). In this case, the literature can be extended from mind wandering during reading and reading comprehension to include mind wandering during online learning and academic performance. Higher levels of mind wandering created deficits (lower levels) of academic performance, and higher levels of working memory capacity predicted lower levels of mind wandering. Similar results and models from different contexts (e.g. reading comprehension) were presented previous findings; other factors, such as mood, stress, mindfulness, and topic experience may also influence mind wandering and performance (Kane et al., 2007; Kane & McVay, 2012; Mrazek, Smallwood, & Schooler, 2012; Smallwood et al., 2009; Unsworth & McMillan, 2012).

Topic Interest

Topic interest in the present study extended the existing literature beyond text reading to new findings in digital media. Unsworth and McMillan (2012) proposed that topic interest did not directly predict mind wandering; however, interest predicted mind wandering. Lindquist and McLean (2011) presented only a marginal \( r = -.14, p < .01 \) negative correlation between course interest and mind-wandering rates during a 40-minute, traditional lecture. In Figure 5, the estimated standardized total effects of
interest on TUTs were ($\beta = -.66$) or 44% of the variance in mind wandering. Higher
interest in the video topics was significantly related to lower rates in mind wandering. In
the present study, interest in the topics presented in the videos was measured before and
after two video trials; whereas, interest in the Unsworth and McMillan (2012) study was
only measured after reading with considerations for the topic of the text and the topic in
general. Perhaps the difference in findings is related to the method of measuring topic
interest or expectations in interest are different for digital media, compared to reading or
traditional lectures.

**Motivation—Academic Goal Orientations and Mastery Approach**

Unsworth and McMillan (2012) reported that individuals with higher levels of
motivation had lower levels of mind wandering. Yet, previous research has only
explored motivation in terms of the task and test performance. In the field of Educational
Psychology, motivation is often evaluated in terms of achievement goal orientations to
better understand general approaches to learning; the present study extends the literature
on motivation and mind wandering to consider goal orientations.

Individuals who self-identify as master approach are interested in mastering
content as a life goal and are not particularly interested in test scores, more learning for
the sake of learning. It is no surprise then, to find that subjects with higher levels of
mastery approach orientations experienced lower levels of mind wandering (Figure 6,
estimated standardized direct effects of mastery approach on TUTs were $\beta = -.40$), as
they were focused on mastering the presented content and less prone to distraction.
Figures 7 and 8 presented good fitting models with more moderate relationships between
mastery approach and mind wandering; in both models, this estimated standardized direct effect was not significant. This lack of significant effects was likely due to the high level of variance in mind wandering explained by topic interest that pulled variance away from mastery approach. Also, the correlations between mastery approach and Interest1 ($r = .18$, $p = .04$) and Interest2 ($r = .26$, $p < .01$) were only moderate values. Unsworth and McMillan (2012) reported that motivation mediated interest and TUTs; although the current study lacked significant parameters in the mediated relationship, Figures 7 and 8 matched the direction of the relationship (higher levels of motivation/mastery approach, lower levels of mind wandering; higher levels of interest, higher levels of motivation/mastery approach). Perhaps the difference in findings was due to the varying measures of topic interest and motivation in both studies. It could also be argued in the current study that performance goal orientations are less influenced by topic interest than motivation specifically directed to the topic and performance task.

It was a bit surprising to find no significant paths in the exploratory structural equation model (Figure 6) between performance approach and TUTs. In theory, subjects with higher performance approach orientations would also focus on the content with the goal to perform well on subsequent assessments and be less prone to distraction; nonetheless, subjects with higher performance approach orientations were related to higher point totals the course ($r = .24$, $p < .01$).

**Task-Related Interference**

Previous research explored the relationships among TUTs, WMC, and performance but gave little analysis to task-related interference, noting that it was an
ambiguous category of thought between on-task and off-task thinking (Kane & McVay, 2012; McVay & Kane, 2012b; Unsworth & McMillan, 2012). The current study aimed to explore TRI and other factors by substituting TRI for TUTs in the structural equation models to examine those relationships. In the primary exploratory model, the only significant path from goal orientations to TRI was mastery approach; it makes sense that those mastering content would continually evaluate their understanding of the presented subject matter and thereby experience higher levels of task-related interference. Subjects with higher mastery approach reported higher levels of interest and higher instances of task-related interference. In theory, those with the goal to master content would likely report increased levels of interest in the subject matter.

Although the relationships among TRI, interest, and mastery approach seemed straightforward and supported by theory, the predictive relationships among working memory capacity and academic performance required a bit more interpretation. TRI did not have significant relationships with academic performance or working memory capacity. Although it has been established that WMC had a moderate predicative ability on TUTs, the lack of the same relationship here may have solidified that task-related interference and mind wandering are different cognitive constructs. Without a significant direct path between TRI and academic performance, it is inconclusive to say that experiencing task-related interference is advantageous or detrimental for performance; however, this finding may be limited by the measurement of academic performance in this particular study (to be explained later). Given the lack of significant relationships
among TRI, academic performance, and WMC, it can be interpreted that TRI is a distinct and potentially still ambitious state of mind between on-task and off-task thinking.

For the purpose of simplifying the novel reported findings in task-related interference, consider a new construct, the TRI Mastery Approach Hypothesis. Figure 7 illustrated the framework of this hypothesis that higher levels of mastery approach orientations predict higher levels of task-related interference.

**Limitations**

**Sample Size**

As with any study, sample size is a potential limitation. Structural equation models and model fit statistics (particularly chi-square and RMSEA) can be strongly influenced by sample size (Schumacker & Lomax, 2010). Rules of thumb that govern sample-size requirements for SEM are wide ranging from as low as 100 subjects to as many as 5,000 subjects. Two hundred subjects is a standard sample size for SEM; however, complexity of the hypothesized model plays a large part in determining the required sample size (Kline, 2011; Oke, Ogunsami, & Ogunlana, 2012; Schumacker & Lomax, 2010).

Taking the model complexity into consideration for a target sample size, Bentler and Chou (1987) proposed a 5:1 ratio of sample size to number of free parameters in a model. In the most critical finding represented in Figure 4, the ratio of sample size to free parameters is 126:27; therefore, this model is only 9 subjects shy of the 135 target subjects in a 5:1 ratio. Despite the discrepancy in the literature regarding requisites for
sample size in SEM, the reported models have good fit and relatively few variables; therefore, the 126-subject sample size should be adequate to support the findings.

**Total Points and Instructor Bias**

Total points in any classroom can be subject to scrutiny. Academic performance was a latent factor comprised of two quiz scores and total points. Total points were comprised of 14 multiple-choice quizzes, 14 journal reflections, six written media literacy assignments, and two essay-based exams. Subjects were assessed on content from the videos in this study and similar materials each week. Quizzes were objective assessments; journals, media literacy assignments, and exams all contained written components subject to interpretation from seven different online instructors; however, all assessments were evaluated based on the same rubrics and target responses for essays.

Instructors were not made aware of the content of the study and were given specific instructions to relay any participant questions to the principle researcher. See Appendix D. Nonetheless, instructor bias in grading and accumulating total points may be a limitation, but the goal of the study was to evaluate mind wandering with actual course materials and compare instances of off-task thinking during those exercises to deficits in actual classroom performance, a case for including total points in the latent academic performance construct. Although others (e.g., Lindquist & McLean, 2011) also defined performance based on course grades, perhaps the current study would benefit from including standardized measures such as SAT or ACT scores in the academic performance latent construct, as reported in previous studies (e.g., McVay & Kane, 2012b; Unsworth, Brewer, et al., 2012; Was et al., 2011).
Online Delivery

Lastly, online delivery of the study could be a limitation. A laboratory setting can be an ideal method of controlling the research environment; however, the setting in an online education is comprised of more questions about the subject’s environment than answers. Specific instructions were provided (see Appendixes G and H); yet, subjects were free to take the complex span tasks, achievement goal orientation questionnaire, and probed videos in any order and any day or time within a three-week timeframe. As a result, the conditions surrounding a subject participated in this study, necessary to evaluate an online learning environment, were variable and uncontrolled.

However, self-reports of mind wandering in everyday life and related performance have been established and validated against laboratory studies (Kane et al., 2007; Kane & McVay, 2012; Unsworth, Brewer, et al., 2012), and computer-based complex span tasks are reliable and valid measures of WMC (Bailey, 2012). Paolacci, Chandler and Ipeirotis (2010) and Sprouse (2011) conducted experiments in the fully online Amazon Mechanical Turk setting (subjects recruited and paid to complete experiments online) and in traditional lab settings and reported no significant difference in the experimental results, validating fully online research as plausible context for conducting experiments. Although the limitations of the online methodology of this study present limitations, the established validity of mind wandering in everyday life and computer-based WMC measures lessen those limitations and validate the current

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1 During the first week of the study, all span tasks, the achievement goal survey, and video1 were released on Monday (day one). Video2 was not released until Sunday (day seven). However, subjects who opted to begin the study on day seven were not required to wait between video1 and video2. This timing difference between videos could be addressed and controlled in future adaptations of this study.
approach to capturing mind wandering and performance deficits in an actual online environment.

**Instructions and Note Taking**

Prior to completing the complex span tasks, subjects were told to report as many letters/numbers as they could recall in order. Partial-credit scoring was used to calculate span scores; as such, instructions on the span tasks could have been better aligned with the measurement and subjects could have been instructed to report as many letters as they could remember, regardless of sequence. However, few subjects left spaces in the reported letters/numbers in the span tasks, indicating that they were not intentionally aiming to recreate the sequence and skip over missing/forgotten targets.

Span task instructions should have also included numerous reminders not to take notes or write letters to improve performance. Despite receiving instructions not to take notes, 30 subjects reported writing down letters on at least one of the complex span tasks. Twenty-one subjects took notes on more than one span task and were removed from the study, a 14.2% rejection rate. Similarly, Sprouse (2011) reported an identical 14.2% rejection rate in the Mechanical Turk study, where online subjects failed to follow instructions and were removed from the analysis.

Self-reported note taking ranged from 3 letters to “all” letters. It could be argued that taking notes on 3 letters did not create a noticeable increase in a span score; yet, determining a cut-off range for allowable note taking was not discovered in the reviewed literature. If participants who reported 10 or less letters were included in the analysis, the resulting descriptive statistics and models were nearly identical to the presented findings;
in fact, the parameter from mastery approach to TUTs was significant in Figures 7 and 8. If participants who reported 5 or less letters were included, the resulting models and statistics were also nearly identical to the current findings. If all note-takers were included, the statistics and models were quite different. This makes sense, as participants who reported taking more than 10 notes to assist a 75-item task were not accurately representing memory scores. As such, the elimination of note taking data and establishment of a cut-off criteria for note taking data should be discussed in future research.

In the current study, policies prohibiting note taking were not directly stated in the LiveCode instruction sequences. Participants were encouraged to do their best and remember as many letters as possible. Future online studies should discourage note taking during complex span tasks; however, it may be likely that this discouragement may not limit the behavior of taking notes itself but rather the frequency of note-taking self-reports, which presents another challenge in the research design.

Isn’t Some Mind Wandering a Good Thing?

Despite the reported deficits in performance during demanding tasks, mind wandering may be a function to facilitate creativity and future planning (Baird et al., 2012; Mooneyham & Schooler, 2013; Schooler et al., 2011). Baars (2010) argued that to deny all mind wandering is to deny “spontaneous ideation” (p. 208). Baars presented that negative stigma surrounds mind wandering research, where terms such as absentmindedness are indefinitely attributed to poor performance and failures in daily lives. Yet, mathematicians and other problem solvers spend time considering repetitive
thoughts or concepts to achieve successful results. From a neurological prospective, Christoff et al. (2009) proposed that mind wandering may diminish immediate goals, “mind wandering may enable the parallel operation of diverse brain areas in the service of distal goals that extend beyond the current task” (p. 8723).

Baird et al. (2012) proposed that mind wandering during an incubation period between creative exercises increased creativity. To study this effect, subjects determined unusual uses for a stimulus, an Unusual Uses Task (UUT) and either took a rest, completed a demanding task, completed an undemanding task, or immediately moved forward to the second UUT exercise. Subjects completed retrospective mind-wandering questionnaires at the conclusion of the incubation period and after the second UUT. Creativity for the UUTs was measured and compared with mind-wandering responses. Subjects in the undemanding task group reported significantly more mind wandering than other groups and produced higher-rated creative solutions in repeated, not novel, stimuli. Taking a break that involved an undemanding task and promoted mind wandering improved creative thinking on repeated problems more so than other incubation groups. However, delayed mind-wandering reports could limit the findings, given the inaccuracies that can be associated with delayed retrospective judgments (Dunlosky & Metcalfe, 2009).

There was some debate about the propensity for higher working memory capacity individuals to mind wandering about future-oriented, off-task thoughts. If setting future plans and goals was a desirable activity for everyday life, then mind wandering in this regard was a functional effect. Baird, Smallwood, and Schooler (2011) proposed that
autobiographical planning is a desirable and functional capacity of mind wandering; they claimed that off-task thinking was predominately future and self-oriented, and higher WMC individuals experienced more future-oriented mind wandering than those with lower WMC. In contrast, McVay et al. (2013) did not find that higher working memory capacity individuals experience higher rates of future off-task thinking, noting that the small sample size (47 participants) and strictly undemanding tasks performed in Baird et al. (2011) may limit the claims associated with autobiographical planning.

Can Mind Wandering Be Reduced?

Diminished performance in demanding tasks and reports of mind wandering in classroom settings, evaluating methods to reduce instances of mind wandering and improve performance was an important area of study. McVay and Kane (2012b) suggested that the inclusion of “thought control” (p. 316) should be considered an important contributor to reading comprehension training. Smallwood, Fishman, et al. (2007) proposed recognizing and correcting mind wandering is a metacognitive skill, and mindfulness therapy would change the “relationship between individuals and their thoughts” (p. 234) and improve performance in education.

Mrazek and Smallwood (2012) investigated whether mindfulness training could reduce mind wandering. Mindfulness is sustained nondistraction; “where mindfulness ends, mind-wandering begins” (p. 443). Therefore, improving the ability to avoid distraction should in turn reduce mind wandering. In the first experiment, subjects completed two measures of mind wandering during 10-minute mindfulness breathing tasks. Subjects were probed for mind wandering instances in one session and reported
self-caught mind wandering in the other. Subjects were also probed for mind wandering during a SART trial and then completed a Mindful Awareness Attention Scale (MAAS) measurement. High levels of mindfulness were negatively correlated with mind wandering. In the second experiment, subjects either received eight minutes of mindfulness breathing, passive relaxation (rest but not sleep), and casual reading. Subjects then completed the same SART task as the first experiment. The eight-minutes of mindfulness breathing reduced mind wandering compared to passive relaxation and casual reading. Mrazek and Smallwood (2012) proposed that mindfulness training may seem to encourage mind wandering—but distracting thoughts are being trained to be ignored. Also mindfulness training increased metacognitive awareness of mind wandering, allowing attention to be refocused back from off-task thoughts.

Mindfulness training has also been shown to increase GRE and WMC performance and reduce mind wandering (Mrazek, Franklin, Phillips, Baird & Schooler, 2013). In a pre-test, post-test design, subjects receiving two weeks of mindfulness training improved verbal-reasoning GRE scores and OSPAN working memory capacity scores more so than subjects receiving two weeks of nutrition training. Subjects in the mindfulness group also experienced reduced instances of probed and self-reported mind wandering instances measured during the GRE examination. In the mindfulness group, subjects were trained to be mindful of posture, distinguish between off-task and elaborative thoughts, reframe past and future thinking to the present, focus on breathing and allowing the mind to rest rather than suppress thoughts. Subjects in the nutrition group committed the same amount of time to training but focused on basic nutritional
health topics and recorded a food-intake log. Although the findings in this study were promising with regards to the impact of mindfulness training, it should be noted that only 26 subjects participated in the mindfulness group, perhaps limiting the scope of the findings. Also, additional measures of WMC may be necessary to determine if mindfulness training actually improves cognitive function, as the authors claimed.

In the field of online learning, Szpunar, Khan and Schacter (2013) explored the influence of interpolated, random tests and mind wandering. In experiment one, 32 subjects were divided into two groups: no test and test. After watching three of four lecture segments, subjects completed a math distractor tasks and either received a test or no test. Subjects were told testing would be randomized and all subjects would receive a cumulative exam. After the fourth segment, all subjects (a) completed a math distractor task; (b) rated mind wandering during the previous segments; (c) rated how mind wandering increased as the lecture progressed; (d) rated anxiety levels about the final test; and (e) completed the cumulative test. In experiment two, 48 subjects completed the same exercise; however, they were divided into three groups: no test, test, and restudy (presented with questions and answers). Subjects responded yes/no to the experimenter asking the question, *Are you mind wandering?* once during each lecture segment. Subjects were made aware that the experimenter would ask if their attention had drifted from the presented materials; lectures were not paused during mind-wandering probes.

Szpunar et al. (2013) reported that in experiment one, subjects in the tested group reported less mind wandering, took more notes, and outperformed the no-test group on the forth test segment. In experiment two, subjects in the test group outperformed other
groups on the fourth lecture segment and final exam, took more notes, and mind wandered less. However, there was no significant interaction between mind wandering and test performance across groups. These findings take steps towards better understanding testing effects in online learning and mind wandering; yet, the small sample size, few (and less descriptive yes/no) mind-wandering probes, and lack of WMC measures limit the presented results.

**Future Research**

**Content Embedded Tasks**

As complex span tasks incorporate monitoring, inhibiting, and outputting irrelevant information, Was et al. (2011) proposed an alternative view to measuring WMC with content-embedded tasks. A critical difference was that content-embedded tasks maintain and output the same relevant information in working memory. As a result, content-embedded tasks are “processing relevant rather than extraneous” (p. 911). In their study, subjects completed common complex span tasks (OSSPAN, RSPAN, and CSPAN) to create a latent construct across measures; subjects also completed three content-embedded tasks. Subjects were then evaluated on reading comprehension. Content-embedded tasks accounted for 31% of the unique variance in comprehension, compared to only 2% accounted for by complex-span tasks. Was et al. (2011) proposed the nature of reading comprehension requires task-relevant processing among information active in WM, and content-embedded tasks required these same cognitive demands—making the measure a better fit for evaluating associations with comprehension. Also complex span and content-embedded tasks may be separate but
related WM processes; in particular, complex-span (RSPAN and OSPAN) may reflect individual differences in attentional control in the face of distraction.

Given the nature of the established and reported modest correlations between TUTs and WMC, perhaps a study that required both content-embedded tasks and complex-span tasks may also present a difference in unique variance in mind wandering as explained by working memory capacity.

**Video Presentation, Mindfulness, and Mind Wandering**

Videos for this study were taken directly from an online college course, Media Power and Culture. The focus of this course is media literacy and the evolving role of media and society. As such, educators in this course and online education in general may be interested in media presented in the study. Video1 and video2 were counterbalanced both on presentation and format. Each video featured the same speaker, who had years of professional experience in broadcast settings, speaking directly to the camera. Both videos were produced in the same HD studio with attention to quality sound and visuals. Yet inevitably, research in online learning and mind wandering could extend to compare online lectures lesser and greater production qualities. A study could replicate the same design as presented yet expose subjects to the same materials presented in a standard voice-over PowerPoint compared to an improved video production (multiple video clips, voice over, animation, etc.). If the lower production value would be deemed a less demanding task, it is probable that higher WMC subjects would mind wander *more* than those with lower WMC. However, if the improved video production was more
distracting with added details, perhaps subjects with lower WMC would mind wander more.

In terms of topic interest, subjects would need to be exposed to the same content in both video formats, spaced and controlled for time between viewings. The current study would also be extended if participants evaluated interest of the topic and video format.

A study comparing subjects with and without a mindfulness training module before video viewings would also provide additional evidence for the influence of mindfulness, TUT rates, and performance.

**Considerations for Education**

In terms of applying the findings to an educational setting, attention to topic interest and mindfulness training may have the broadest impact on reducing mind wandering. In the presented findings, topic interest accounted for roughly 44% of the unique variance in TUT rates. Although content in a curriculum may be standardized, and students must learn topics of variable interest, those topics should be continually evaluated for relevance and updated as often as possible. Outdated materials that lead to disinterest could likely increase TUT rates and reduce academic performance.

**Conclusion**

As reported in previous findings, increased mind wandering was associated with lower working memory capacity and deficits in performance. The current study extended the existing literature from reading comprehension to real-world online learning and academic performance. Measurements of topic interest in digital media and achievement
goal orientations may also be evaluated in future research. Task-related interference remained to be an ambiguous category of thought that did not directly correlate with performance or working memory capacity; however, higher levels of mastery-approach orientations predicted higher levels of TRI, the *TRI Mastery Approach Hypothesis*. This novel hypothesis in TRI suggested a new direction for mind wandering research, open for further investigation.
APPENDIX A

MIND WANDERING PROBES
Appendix A

Mind Wandering Probes

In the last 5 seconds, what were you just thinking about?

1. The video.

2. How well I’m understanding the video.

3. A memory from the past.

4. Something in the future.

5. Current state of being. (ex) I’m feeling hungry

6. Thinking about or using another technology. (ex) texting; checking Facebook.

7. Other.
APPENDIX B

INTEREST QUESTIONNAIRE
Appendix B
Interest Questionnaire

Video 1
How interested are you in Public Relations?
5—Very Interested
4—Somewhat Interested
3—Neutral
2—Not Very Interested
1—Not at All Interested

Video 2
How interested are you in Advertising?
5—Very Interested
4—Somewhat Interested
3—Neutral
2—Not Very Interested
1—Not at All Interested
APPENDIX C

2X2 ACHIEVEMENT GOAL FRAMEWORK QUESTIONNAIRE (ADAPTED)
Appendix C

2X2 Achievement Goal Framework Questionnaire (Adapted)

Instructions: The following statements represent types of goals that you may or may not have for this class. Select a number to indicate how true each statement is of you. All of your responses will be kept anonymous and confidential. There are no right or wrong responses, so please be open and honest.

1. It is important for me to do better than other students.
2. It is important for me to do well compared to others in this class.
3. My goal in this class is to get a better grade than most of the other students.
4. I worry that I may not learn all that I possibly could in this class.
5. Sometimes I’m afraid that I may not understand the content of this class as thoroughly as I’d like.
6. I am often concerned that I may not learn all that there is to learn in this class.
7. I want to learn as much as possible from this class.
8. It is important for me to understand the content of this course as thoroughly as possible.
9. I desire to completely master the material presented in this class.
10. I just want to avoid doing poorly in this class.
11. My goal in this class is to avoid performing poorly.
12. My fear of performing poorly in this class is often what motivates me.
Appendix D

Instructor Guide

Extra Credit – Introduction
I am excited to announce an upcoming study for my doctoral dissertation! The study is set to run during MPC sessions 12 and 13.

And my potential research participants are your MPC students!

If your students elect to participate, they can earn 100 points extra credit for completing all aspects of the study.

About the Study
I will place an extra credit folder in all Blackboard homepages with information on the study and all materials. This folder will be made available Sunday, April 14th at 8am.

Students must complete all of the following to earn 100 points:

1. Complete 3 memory exercises
2. Complete 1 survey
3. Answer questions during Jumpstart 12 – Public Relations (during session 12)*
4. Answer questions during Jumpstart 13 – Advertising (during session 13)*

*The ‘special edition’ jumpstarts 12 & 13 with questions are linked in Blackboard and hosted on a system outside the normal mpc.kent.edu site

*Students will receive a practice quiz after the jumpstart 12 & 13 videos. These quizzes are not graded, but will help students study for the graded quiz 12 and 13.

Your Instructor Role & Important Information
In order to eliminate threats to research validity, I do appreciate and (really, truly) count on your exact corporation as follows.

The Rules
1. Do not answer any student questions or concerns about the study!
   a. Forward all questions/concerns (big or small) to me.
   b. In your email forward, simply state: “Hi, Student – I am forwarding your question to the principle researcher in the study.”
2. Do not recruit students to participate.
3. IMPORTANT - Do not tell students about the specific content of the study!
   a. If you explore any of the research materials, keep your findings private.
   b. Letting students know questions featured in any part of the study will compromise the results.

Adding 100 Points
I will monitor activity across all MPC students. After a student completes all aspects of the study, I will enter 100 points into an extra credit field in his or her respective MPC Grade Center.
Appendix E

Student Guide A

Extra Credit – Introduction
We would like to investigate how students think and interact with online media. If you choose to participate, you will be asked questions while you watch a Professor Hanson’s video jumpstarts on Public Relations (session 12) and Advertising (session 13), and you will be asked to complete 1 survey and 3 memory exercises.

It will take approximately 1.5 hours (total) to complete the extra credit work.

Confidentiality
Answers to your survey, memory exercises and video questions will be compared with your final course grade and your academic background. This comparison will help us learn more about online students and improve the course. Your performance on these activities will in no way affect your course grade. But completing all of the activities will earn you 100 points extra credit.

It’s important to understand that Professor Hanson and your section instructor will not have access to your answers. Your responses will be stored in a secured location outside Blackboard Learn. So, please do answer honestly and the best of your abilities, so your responses can help shape this course for the better.

Your responses will be tied to your KSU username, so you can receive extra credit. But your username will be reassigned a random number to analyze the overall study results. So your answers will not be associated with you in any publication or made available to your section instructor or Professor Hanson. As a result, your individual results will remain confidential.

About Extra Credit
You will be sent reminders to update your progress in the study. Your results will be confidential and only collected by the principle researcher, a doctoral student at Kent State University. The principle researcher will inform your MPC instructor if/when you complete the study and earn 100 extra-credit points. The principle researcher will not disclose any of your individual answers.

You must fully complete all aspects of the study to earn 100 points extra credit. If you are missing any entries, you will earn 0 points.

Alternative
If you do not wish to participate in the research study, you have an alternative option to earn extra credit. You can complete an alternative, 100-question examination over the course textbook. You must score 87 or better on the exam to earn 100 points extra credit. Scores lower than 87 will earn 0 points extra credit.

If you are interested in the alternative option, contact the principle researcher, rbhollis@kent.edu by April 19th at 11pm EST.

SAS Accommodations
If you require closed-captioning for the jumpstart videos, please contact the principle researcher, Ben Hollis (rbhollis@kent.edu) for access to those materials.

Consent
Yes, I agree to participate in the study.
Click the link above to access the research materials. By completing any of the research items (ex, you submit the online survey), you give consent for your information to be collected and used in the study.

No, I do not wish to participate in the study.
Click the link above to access the standard video jumpstarts for weeks 12-13. You will not earn extra credit.
APPENDIX F

STUDENT GUIDE B
Appendix F

Student Guide B

Extra Credit: Requirements

1) Jump Starting “Public Relations” (click this link)
During this jumpstart, you will be asked questions as you watch the video. Set aside 15 minutes to watch the video start-to-finish in one sitting.
After the video, you will be given a short practice quiz. Do your best to answer correctly, but know that practice scores will not count for your course grade. However, you will be tested on information covered in the jumpstart for Quiz 12.

2) MPC Survey (click this link)
Complete a 12-item survey about yourself as a student in Media Power and Culture.

3) Memory Exercises (see links below)
Each memory exercise should take approximately 20 minutes to complete. Plan to complete each exercise in one sitting - in other words, do not start/stop/restart the exercise. Please answer all questions to the best of your ability.
Performance on the exercises will not impact your course grade.
Do not write-down or take notes to assist with your memory exercises. Just do your best.

» Instructions & Links
1. Watch the video walk-through for MAC or PC.
2. Install the KSU VPN for MAC or PC.
3. Download memory exercises for MAC or PC.
4. Start the KSU VPN.
5. Run and complete WMBATTERY 1-3.
6. Delete memory exercise files & folders from your computer.

4) Jump Starting “Advertising” (click this link) .. made available, Sunday 8AM, week 2
During this jumpstart, you will be asked questions as you watch the video. Set aside 15 minutes to watch the video start-to-finish in one sitting.
After the video, you will be given a short practice quiz. Do your best to answer correctly, but know that practice scores will not count for your course grade. However, you will be tested on information covered in the jumpstart for Quiz 13.
REFERENCES
REFERENCES


