Thoughtful Learning: An Investigation of the Relationships Between College Students’ Achievement Appraisals and Thinking Patterns During Lecture

Shelby Lynn Smith

University of New Hampshire

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THOUGHTFUL LEARNING: AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN COLLEGE STUDENTS’ ACHIEVEMENT APPRAISALS AND THINKING PATTERNS DURING LECTURE

BY

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DISSERTATION

Submitted to the University of New Hampshire in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy in Psychology: Brain, Behavior, & Cognition

December 2023
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On September 15th, 2023

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DEDICATION

This dissertation is dedicated to my parents: Rob, Belinda, and Donna. I truly could not (and would not) have finished this project without their unwavering support, guidance, and love.

I wrote this for them. My accomplishment is their accomplishment.
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I would first like to thank my doctoral advisor, Caitlin Mills, for everything over the last five years. I really do not have the words to adequately express my immense gratitude for (a) her never-ending patience when my eyes were filled with tears and I was losing my mind, (b) her willingness to politely push me when I needed it (which was often), and (c) forever intertwining our brains because extended cognition, am I right?! 😊 But in all seriousness, she never gave up on me even when I repeatedly gave up on myself and, for that, I am eternally grateful.

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Lastly, I would like to thank my two research assistants for their help in this project: Elizabeth Phelps and Justine Scattarelli. What they provided at exactly the time I needed it is worth its weight in gold.
ABSTRACT

THOUGHTFUL LEARNING: AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN COLLEGE STUDENTS’ ACHIEVEMENT APPRAISALS AND THINKING PATTERNS DURING LECTURE

BY

SHELBY LYNN SMITH

University of New Hampshire, December 2023

The current set of studies examined whether two common appraisals that students make during learning (whether they have control over their learning and whether they place value into learning the material) give rise to common types of thoughts students also experience (mind wandering, personal connections, and freely-moving thought). Study One naturistically examined students’ appraisals and thoughts while learning in a real classroom. Study Two attempted to experimentally manipulate students’ appraisals and thus their thoughts in an online learning environment. Overall, results suggest that appraisals do seem to influence the thoughts students report experiencing, although results differ between online and classroom learning environments.
Students experience a wide variety of emotions throughout their education, such as worry pertaining to an upcoming exam or pride regarding an excellent grade. Their emotions are often paired with related thoughts, such as “I’m never going to be able to do well on this exam” or “I’m so glad I did the extra credit because it really helped me nail that assignment!” Students’ perceptions of their own abilities, their instructor, and how well they are learning combine to give rise to their learning experiences. For example, if a student does not feel like the content of a particular course is valuable for them to learn, they might experience wandering thoughts during class that center around topics that are unrelated to the lecture but more important to them. A prevailing theory, the Control-Value Theory of Achievement Emotions (CVT), proposes how students’ interpretations of their learning and learning environment impact the emotions they have during learning (Pekrun, 2006). Pekrun (2000; 2006) took an integrative approach to better understand the processes involved in how various emotions arise by incorporating phenomena across different areas of the psychological literature (e.g., motivational, cognitive, etc.). In doing so, he provided a clearer picture of the mechanisms that engender students’
emotions that subsequently affect academic performance. The relationships between students’ perceptions, emotions, and academic outcomes have been extensively researched since then (see Pekrun, 2022 for a review). However, this body of work focuses primarily on how students’ emotion states arise without much consideration of the other experiences students have during learning, such as their thoughts. The cognitive and motivational mechanisms that create students’ emotional experiences may also contribute to what they think about throughout learning. This dissertation will therefore examine how Pekrun’s (1992; 2000; 2006) ideas can be applied in a novel way to explain the phenomenology of various types of thoughts students commonly experience in the classroom.

**Cognitive Appraisals and the CVT**

The crux of the CVT is built on the concept of cognitive appraisals. Lazarus and Folkman (1984) define cognitive appraisals as “the process of categorizing an encounter, and its various facets, with respect to its significance for well-being” (p. 31). Cognitive appraisals are evaluative processes; these evaluations largely operate below conscious awareness but give rise to various conscious states (Lazarus & Folkman, 1984; Lazarus, Kanner, & Folkman, 1980; Smith & Ellsworth, 1985). For example, an individual may cognitively appraise how they feel about a new television show by making judgments such as the interest they have in the topic, how likeable the characters are, and/or whether the plot is novel and intriguing. Thus, what we ultimately experience are phenomenological manifestations of many different cognitive appraisals (Lazarus, Kanner, & Folkman, 1980).

Appraisals are variable and multi-faceted. Specifically, cognitive appraisals are iterative in that individuals continually make and remake evaluations about their world (i.e., reappraisals). Lazarus, Kanner, and Folkman (1980; Lazarus & Launier, 1978) conceptualize the dynamics of
experiencing an emotion as a result of “ongoing relationships or transactions in which the person influences and is influenced by the environment, especially the social environment” (p. 195). As such, the process of reappraising a given scenario routinely builds our changing experience of emotion (and perhaps the content of our thoughts over time as well; Lazarus & Folkman, 1984; Lazarus, Kanner, & Folkman, 1980; Smith & Kirby, 2011).

Smith and Ellsworth (1985) proposed a dimensional model of the appraisals involved in emotional experiences. Their approach added nuance to our understanding of how emotions arise and impact our day-to-day functioning by testing (a) what appraisals individuals routinely make, and (b) the degree to which different dimensions of appraisals contribute to the experience of various emotions. Their results showed that it is not just one dimension of appraisals but rather combinations of appraisals that form patterns to ultimately give rise to our phenomenological experiences.

Pekrun’s (1992; 2006) CVT identified two such appraisals that he argues are critical in developing students’ learning experiences: value and control—both of which are reviewed in more detail below.

**Control Appraisals.** Pekrun (2006) conceptualized prospective appraisals of control as originating from expectancies as to (a) who has control (either the individual’s actions or the situation) and (b) the outcome of a given scenario. Altogether, individuals’ appraisals of (and understanding about) the control they have over a scenario are dependent upon initial situation-outcome, action-control, and action-outcome expectancies. Prospective situation-outcome, action-control, and action-outcome expectancies as well as retrospective attributions pertaining to appraisals of control are defined in Table 1.
Table 1. Conditions for Appraisals of Control based on the Control-Value Theory of Achievement Emotions (Pekrun, 2006)

<table>
<thead>
<tr>
<th>Type</th>
<th>Expectancies</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Outcome</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expectancy that the situation will lead to a positive outcome without the individual taking action or the situation will lead to a negative outcome if the individual does not take action</td>
</tr>
<tr>
<td>Situation</td>
<td>Expectancy that the situation has the capacity to determine the amount of control an individual has</td>
<td></td>
</tr>
<tr>
<td>Action</td>
<td>Expectancy that the individual can take action to meet goal</td>
<td>Expectancy that the individual will take action to meet goal</td>
</tr>
</tbody>
</table>

Note. Pekrun (2006) did not define situation-control expectancies, however I have offered a plausible definition based on Pekrun’s ideas.

In appraising subjective control prospectively as well as during an activity, the individual must evaluate whether they have the means to be [and continue to be] successful (or avoid failure). For example, when an individual sets out to achieve an academic goal (e.g., writing a term essay), their appraisal of control is theorized to be high (leading to a positive outcome, like success) when either their (a) situation-outcome expectancy of the situation is highly positive or (b) action-control and/or action-outcome expectancies of their personal abilities are high. Therefore, if the individual expects that they will do well on the essay without requiring much effort on their part (e.g., if the instructor grades easily or the classwork is not demanding on the student) or if the individual expects that they are able to devote enough effort into writing the essay (e.g., if the student is highly motivated and knows they are capable), then the individual’s appraisal of control over their final grade on the essay is high. Likewise, the individual’s
retrospective attribution regarding their essay grade is considered internal and can positively contribute to their appraisals of control centering around the essay or future work.

The individual’s appraisal of control is theorized to be low (leading to a negative outcome, like failure) when either their (a) situation-outcome expectancy of the situation is highly negative or (b) action-control and/or action-outcome expectancies of their personal abilities are low. Thus, if the individual expects that they will not do well on the essay without requiring a lot of effort on their part (e.g., if the instructor is a hard grader or the class is very difficult) or if the individual expects that their abilities and effort will not be enough for writing a well-done essay (e.g., if the student does not believe in themselves or struggles with understanding the material), then the individual’s appraisal of control over their final grade on the essay is low. This individual’s retrospective attribution regarding their essay grade would be considered external and can also negatively contribute to their appraisals of control about the essay or future work.

Value Appraisals. Appraisals of value are based on whether an individual strives to avoid failure [or does fail] or to achieve success [or is successful] (high value appraisal) or places low or no value on an academic activity/outcome. In the above scenario about a student writing a term paper, the value an individual appraises regarding writing the paper can also impact the actions they take and the outcome of their actions (see Table 2). If the individual appraises the essay assignment as something personally valuable to them (e.g., if they genuinely want to do well and learn more about a topic or enjoy exercising their writing skills), then their appraisal of value is inherently intrinsic [and not specifically related to academic success]. If the individual appraises the essay assignment as something instrumental to the development of their careers or college success, then their appraisal of value is thus extrinsic [and places importance on
academic success]. Intrinsic and/or extrinsic value placed on academic performance leads to high appraisals of value, which ultimately pushes individuals to exert effort on learning. On the contrary, individuals can experience low intrinsic and/or extrinsic value (e.g., if they are not interested in the essay topic or the class in which the essay was assigned is not important for their long-term career goals), leading to low overall appraisals of value.

<table>
<thead>
<tr>
<th>Appraisals of Value</th>
<th>Type</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intrinsic</td>
<td>Extrinsic</td>
</tr>
<tr>
<td>Personal value for an activity, action, or outcome, regardless of success</td>
<td>Instrumental value or usefulness of activity, action, or outcome</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Conditions for Appraisals of Value based on the Control-Value Theory of Achievement Emotions (Pekrun, 2006)

It is worth noting that some of the concepts from the CVT (Pekrun, 2006) are grounded in Eccles and Wigfield’s (2002; Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983) Expectancy-Value Theory. Specifically, regarding the concept of values, the Expectancy-Value Theory differentiated value appraisals by more than simply intrinsic and extrinsic. The authors conceptualized three other variations of interpreting the value of a [non-academic] task to an individual: attainment value, utility value, and cost value (Dietrich, Viljaranta, Moeller, & Kracke, 2017; Eccles & Wigfield, 2002). Attainment value has to do with how personally important an individual perceives their success on a given task or learning something is. Utility value concerns when individuals appraise the usefulness of mastery of a topic or success on a task. Opposite to appraisals of intrinsic, extrinsic, attainment, and utility value, cost value pertains to how negative an individual perceives participating in a task or learning about a topic.
will be. Appraisals of cost value have been further subdivided into three facets, including effort (how tiring learning about a topic or engaging in a task will be), emotion (how negatively an individual will feel immediately after learning or completing a task), and opportunity (how many other valued activities an individual will have to give up to learn or do something; Gaspard, Dicke, Flunger, Schreier, Härter, Trautwein, & Nagengast, 2015; Perez, Cromley, & Kaplan, 2014).

One study empirically tested the extent to which varying degrees of expectancy appraisals in conjunction with varying degrees of value appraisals constructed different experiences of emotion (Berweger, Born, & Dietrich, 2022). Results showed that expectancy and value appraisals interacted to predict both frustration and boredom, such that frustration and boredom were both higher when cost value was high (e.g., students might fail the class if they did poorly on the exam) and expectancies were low (e.g., students did not expect they would do well on the exam). Despite the nuance in value appraisals provided by the Expectancy-Value Theory, Eccles and Wigfield (2002) solely focus on the role of prospective expectancies whereas Pekrun (2006) takes a time-based approach by considering both prospective attributions and retrospective expectancies when understanding achievement emotions.

Why Appraisals Matter: The Impact of Appraisals on Students’ Learning Experiences

A large body of work has repeatedly shown how emotions arise in relation to the achievement appraisals that students continually make (Pekrun, 2022). Emotions experienced at any time throughout learning can be as fleeting and temporary (state) as a spontaneous thought or as recurring and dispositional (trait) as ruminative thinking. Pekrun (2006) classified emotional experiences over time by detailing how students’ affective responses regarding learning can change based on achievement appraisals (See Table 3). As control and value
appraisals change throughout a learning task (e.g., lecture, homework assignment, quiz, etc.), so too do individuals’ experiences. For example, Pekrun and colleagues (2010) explored the relationships between perceived control and value appraisals and boredom with other variables, such as attention, motivation, effort, strategy usage, self-regulation, and more during both a single learning session and over time. Their results broadly found that control and value appraisals directly impacted experiences of boredom which affected students’ attention, tendency to use elaborative learning strategies, intrinsic motivation, effort, and self-regulation in addition to academic performance. These results highlight not only the importance of measuring the dynamics of changing appraisals but also the various other cognitive phenomena students experience as a result of the appraisals they make and emotions they experience.

<table>
<thead>
<tr>
<th>Focus (Time)</th>
<th>Appraisals</th>
<th>Control</th>
<th>Emotion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>(Prospective)</strong></td>
<td>Positive (Success)</td>
<td>High</td>
<td>Anticipatory Joy</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>Low</td>
<td>Hope</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>Anticipatory Relief</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Negative (Failure)</td>
<td>Moderate</td>
<td>Low</td>
<td>Hopelessness</td>
</tr>
<tr>
<td><strong>Activity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>(During)</strong></td>
<td>Positive (Success)</td>
<td>High</td>
<td>Enjoyment</td>
</tr>
<tr>
<td></td>
<td>Negative (Failure)</td>
<td>High</td>
<td>Anger</td>
</tr>
<tr>
<td></td>
<td>Low or None</td>
<td>Low</td>
<td>Frustration</td>
</tr>
<tr>
<td></td>
<td>Irrelevant</td>
<td>High or Low</td>
<td>Boredom</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>(Retrospective)</strong></td>
<td>Positive (Success)</td>
<td>Irrelevant</td>
<td>Joy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self</td>
<td>Pride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
<td>Gratitude</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irrelevant</td>
<td>Sadness</td>
</tr>
<tr>
<td>Negative (Failure)</td>
<td>Self</td>
<td>Self</td>
<td>Shame</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>Other</td>
<td>Anger</td>
</tr>
</tbody>
</table>

*Note.* This table was adapted from Table 1 in Pekrun (2006; p. 320).
Cognitive appraisals were originally defined as evaluative processes that can be broadly applied to various phenomena beyond emotions (Lazarus, Kanner, & Folkman, 1980). A small but growing area of the literature has thus begun to map the nature of appraisals with manifestations of other phenomenological experiences individuals have. For example, appraisals have been related to student engagement. The amount of challenge that students appraise a mathematics homework assignment to have is predictive of their self-reported effort, such that when a math assignment is perceived to be too challenging (or rather out of their control), less effort tends to be exerted (Dettmers, Trautwein, Lüdtke, Goetz, Frenzel, & Pekrun, 2011). Dettmers and colleagues (2011) also found that when students perceived the homework selection as well-prepared by the instructor and also believed the homework was valuable for them to complete, they tended to exert more effort when doing the assignment. When students do not perceive the importance of putting in effort to complete an assignment, it is conceivable that they would also experience mind wandering related to carelessness or ruminative thinking related to frustration given negative emotion and wandering thoughts are related (Smallwood, Fitzgerald, Miles, Phillips, 2009). Another study specifically measured students’ likelihood experiencing cognitive approach (e.g., changing how they perceived the learning situation to be potentially valuable to them) and cognitive avoidance (e.g., thinking about something unrelated to and/or less unpleasant than a learning task) coping strategies throughout learning. Results showed that individuals who reported experiencing more approach-based strategies during learning (akin to value re-appraisals) also reported experiencing less boredom in the classroom (Nett, Goetz, & Hall, 2010). Perceiving learned information to be valuable and thus being interested (or not bored) could also engage students to think in unconstrained ways connecting information to their
personal lives or related memories. Overall, these few studies highlight a direct relationship between how students’ perceptions of and appraisals related to learning impact engagement beyond just the experience of emotions. However, this relationship leaves open much work to be done to investigate how appraisals during learning give rise to other cognitive phenomena experienced during academic tasks.

**Appraisals and Attention.** Individuals’ thoughts can depend on their degree of attention, such that a student who is not paying attention to a lecture may be experiencing task-unrelated, wandering thoughts (Franklin, Smallwood, Zedelius, Broadway, & Schooler, 2016). For example, if an individual appraises the activity as having high value to the individual (whether intrinsically, extrinsically, etc.) but they have low control over the outcome (e.g., if the instructor grades harshly, etc.), they can feel frustration regarding the quality of their work during and throughout their completion of the task. This frustration could be accompanied by task-related focused thinking to resolve the negative emotions and complete the assignment or task-unrelated thoughts (TUTs) because of their frustrated emotions rather than the assignment. Conversely, if the activity is appraised as having little to no value to the individual regardless of their subjective appraisal of control, Pekrun (2006) theorized that they will feel boredom when completing the task. When students are bored, they are often attentionally disengaged and therefore could be thinking about a variety of topics. For example, Pekrun and colleagues (2010) conducted a study to analyze the correlates of boredom using participants’ written descriptions of the thoughts they had when they were feeling bored. They found relationships between boredom and lack of attention, which they concluded was because the content of students’ thoughts was disconnected from the learning material during boredom.
Additionally, in a new meta-analysis, it was shown that students experience TUTs about 1/3 of the time they spend learning on average (Wong, Smith, McGrath, Flynn, & Mills, 2022). In another study, researchers found that 6.7% of the TUTs those students reported experiencing were directly caused by boredom and disinterest (other attentional disengagements related to mind wandering could be distraction, feeling tired or hungry, etc.; Unsworth & McMillan, 2017). The cognitive processes that give rise to emotions during learning are likely intimately tied with the thoughts students experience during learning, however we know very little about this process.

**Appraisals and Other Phenomenological Experiences.** Conversely, students who are engaged during learning may experience freely moving thought (Mills, Raffaelli, Irving, Stan, & Christoff, 2018) or generate personal connections with the information (Bluestein, 2002; Williams, 2001). Some research has been conducted on other dimensions of thought (e.g., freely-moving thought and personal connections), which distinguishes between a variety of phenomenological experiences students have during learning. Freely-moving thought (FMT) is a dimension of thought in which the content of what an individual is thinking about freely moves from one thing to the next without constraints binding the subject matter (e.g., thinking about how cute your pet is which leads you to wondering about how your parents are and then thinking about an upcoming date you have versus ruminating over the best topic to write about for your final term essay without being able to think about much else; Mills, Raffaelli, Irving, Stan, & Christoff, 2018; Mills, Porter, Andrews-Hanna, Christoff, & Colby, 2021). Personal connections (PCs) are another type of thinking that includes associations between something in an individuals’ environment (e.g., information learned during a lecture, content being read, etc.) and either semantic or episodic information that is *personally relevant* to an individual (Bluestein,
2002; Williams, 2001). Thus, we may be able to better understand how appraisals shape various thoughts by first understanding the disconnect between the content of students’ thoughts and the content of the learning material. This may be especially so for thoughts that do not fit neatly into a definition of TUT. Therefore, the extensive variety of thoughts we can experience throughout learning deepens the role of how appraisals may construct students’ phenomenological experiences.

**Applying Achievement Appraisals to Understand Students’ Experiences**

Despite the large existing body of work, the majority of research on the CVT (Pekrun, 1992; 2000; 2006) has focused on mostly just emotions and mostly just using pre- and post-test types of research designs. There is thus a large gap in the literature that is worth investigating to better accommodate student learning and more comprehensively account for students’ experiences. Specifically, this dissertation will focus on addressing the gaps by understanding (a) how appraisals are related to the various kinds of online, activity-based phenomenological experiences students have during learning such as TUTs, FMT, and PCs by using methodology to measure (b) the changes in how students’ appraisals and phenomenological experiences unfold over time rather than at one point in time. The current research aimed to capture Pekrun’s (1992; 2000; 2006) ideas to better understand students’ experiences throughout learning more broadly, which ultimately leads to new ways researchers and educators alike can address students’ needs and improve their academic performance.

The first novel aspect of my dissertation is capturing students’ momentary appraisals and experiences during learning. Most of the existing work has measured appraisals via questionnaires before or after engaging in some educational task (e.g., reading, writing an essay, etc.)—with a few notable exceptions (e.g., Bieg, Goetz, & Hubbard, 2013 and Mills, D’Mello, 

Kopp, 2015). Similarly, almost no work has attempted to experimentally induce appraisal patterns in students because the majority of the literature has used correlational designs (though again, see Mills, D’Mello, & Kopp, 2015, Mulvenna, Adie, Sage, Wilson, & Howat, 2020, and Yperen, Blaga, & Postmes, 2015 for exceptions). Therefore, the relationships between online appraisals, emotions, thinking patterns, and learning outcomes calls for future work to implement methodology that empirically tests exactly how online mechanisms give rise to students’ experiences.

To more closely assess the role of online appraisals in constructing students’ experiences, Bieg, Goetz, and Hubbard (2013) conducted a study specifically to measure state emotions and online appraisals using experience sampling methodology in addition to trait-based, retrospective measures. Experience sampling is a data collection method that briefly interrupts individuals while they are completing a task to collect various measures of their thoughts, feelings, and more in the moment they are experienced. Bieg, Goetz, and Hubbard (2013) corroborated past research by showing control and value appraisals measured during learning significantly predict experiences of achievement emotions. When students perceived themselves as having high control over their learning outcomes and they highly valued the learning experience, there was an increase in feeling pride and decrease in feeling anxiety. Appraisals of control and value interacted to predict experiences of boredom; students who placed lower value on their learning experience felt more bored as their perceptions of control increased and those who placed higher value on their learning experience felt less bored as perceptions of control increased. Interestingly, these patterns generally held across both trait and state experiences. However, state measures more positively predicted feelings of boredom in relation to control appraisals than trait measures. There is an important difference in how appraisals manifest emotional and
phenomenological experiences when reflective (after the fact) or online. These results clearly demonstrate an added level of nuance necessary for understanding students’ learning experiences. Precisely measuring when students appraise their learning, feel various emotions, and think a multitude of possible thoughts is now a critical endeavor toward ultimately improving learning outcomes.

Taking such momentary experiences into account, Mills, D’Mello, and Kopp (2015) conducted a study in which they assessed the degree to which experimentally manipulated appraisal conditions influenced learners’ online thoughts and affective experiences. To elicit appraisals of low control, the researchers had some participants read a syntactically and semantically difficult text and other participants read a significantly easier text (on the same topic and with the same length) to induce high control appraisals. To manipulate appraisals of value, participants were told that their performance on subsequent comprehension questions for each text was either weighted normally (i.e., low value) or was worth three times that of one text (i.e., high value). Participants also answered experience sampling probes assessing their affective state (from positive to negative), level of arousal (from sleepiness to high arousal), and TUTs interspersed throughout their reading. The authors found that manipulations of value directly impacted students’ experiences of affect and arousal as well as their knowledge transfer [from the text to a novel scenario]; these results suggest that more highly valued texts (i.e., those in which participants’ comprehension performance weighs 3x the amount of one text) elicited more negative affect, higher arousal, and better knowledge transfer. Methodologically implementing experience sampling and experimentally manipulated conditions of appraisals has unmistakably helped researchers to better understand students’ online experiences during learning. However, Mills, D’Mello, and Kopp (2015) did not find an effect of appraisal manipulations on
participants’ rates of TUTs, which is not in line with results from Pekrun and colleagues (2010). This discrepancy suggests that there may be more room for investigation and use of methodological advances to further explain the role of appraisals on the content, frequency, and type of thinking students experience beyond the more traditional research on achievement emotions.

**Dynamics of Thought.** As it currently stands, the literature on Pekrun’s (1992; 2000; 2006) CVT has focused on understanding how appraisals influence the experience of emotion within isolated sessions in different educational domains (e.g., math, reading, second-language learning, etc.). However, Pekrun (2006) emphasizes the dynamic nature of emotions because appraisals shape emotional experiences throughout a given block of time. Shifts in the experience and intensity of emotional experiences can cause a reciprocal feedback loop which similarly shapes individuals’ subsequent appraisals. This means that a person’s appraisals impact their emotions, and those emotions then impact their later re-appraisals (and so forth) depending on which emotions are experienced and how intense those emotions feel. In the context of academia, students’ appraisals and emotional experiences change throughout learning. For example, students might place a lot of value on a particular class and begin listening to the next lecture feeling confident in themselves because they appraised their learning experience as under their control; however, midway through the lecture, the material might become more difficult and so students reappraise themselves as having less control over their learning and begin to worry. With this in mind, research in this body of work falls short by not fully understanding (a) how control and value appraisals as well as various phenomenological experiences change throughout time spent learning, and (b) how changing appraisals throughout one task can have dynamic causal effects on students’ learning experiences during later tasks, such as a student
applying what they learned in lecture to complete a homework assignment. Therefore, addressing the gaps in implementing methodology to measure changes in students’ appraisals throughout learning will provide a more naturalistic account of students’ experiences by capturing realistic shifts in their learning.

Some literature has implemented longitudinal methodology to assess whether and how students’ appraisals change over time. For example, research has shown that feelings of enjoyment (collected at one time point) significantly predicted appraisals of control, intrinsic value, achievement value, and utility value (three months later), which predicted subsequent feelings of enjoyment an additional three months later in sixth grade students (Putwain, Pekrun, Nicholson, Symes, Becker, & Marsh, 2018). Another study found that, over the course of several months in sixth grade math classes, appraisals of control typically did not change over time (i.e., students continuously feel as if they have high or low control over their learning outcomes), but appraisals concerning the value of the learning material in addition to feelings of enjoyment regarding the material decreased (Buff, 2014). Garn, Simonton, Dasingert, and Simonton (2017) found that initial levels of emotional engagement positively predicted later appraisals of control and value and feelings of enjoyment as well as negatively predicted later feelings of boredom in college students [taking golf and tennis classes] over several weeks. Despite the aforementioned research measuring appraisals and emotions over time, this work has been largely limited to weeks- or semester-long investigations rather than measuring similar shifts throughout a homework assignment or lecture. Therefore, the use of longitudinal designs does not capture changing momentary experiences, such as emotions, TUTs, FMT, and PCs at various time points throughout learning. Precision in classifying and measuring students’ experiences during
learning over multiple time points will provide a more accurate and comprehensive illustration of learning.

The changes in the appraisals that students make throughout learning may also continuously form changes in how students’ thoughts transiently unfold over time. Pekrun’s (1992; 2000; 2006) original theoretical blueprints featured ideas centered around how the process of learning and students’ everchanging expectations about their academic success affects achievement emotions. Thus, students’ emotions (and thoughts) can dynamically shift over time and with different experiences (Lazarus, Kanner, & Folkman, 1980). Cavanagh and colleagues (2021) showed this to a degree by investigating whether different reappraisal strategies taught prior to class changed students’ learning outcomes as well as their mindfulness [to ultimately regulate emotion] over the course of a semester and across semesters. Overall, all reappraisal strategy conditions did positively impact learning in the long-term, suggesting that thinking about the course content and focusing on one’s academic appraisals at different points throughout learning improves academic outcomes. The results of this study show us that (a) students’ ongoing thoughts and feelings can change over time and (b) altering one’s appraisals can change students’ emotional experiences. What we do not yet know is what specific online phenomenological experiences are impacted by momentary changing appraisals as well as how reciprocal relationships between changing appraisals and thoughts throughout learning manifest.

The little research that has been done on achievement appraisals and learning over time fails to zoom in on the ever-evolving nature of distinct phenomenological experiences that students commonly have throughout a task or a lecture. Such experiences can cause ripple effects in the moment on students’ learning. Using methodology to measure momentary changes in students’ appraisals, thoughts, and emotions throughout various related academic tasks may
provide a more precise and pragmatic perspective on the dynamics of learning experiences. The degree to which appraisals transform throughout learning and how those transforming appraisals directly impact learning outcomes is thus an important venture for future work.

**The Current Study**

The current pair of studies aims to address two areas of the CVT literature with open avenues for research: online phenomenological experiences and dynamics of thought. Addressing these two gaps in the literature can provide an empirical framework to address a third gap—which is detecting and responding to students’ appraisals. These two studies concentrated on applying the basic theoretical tenets of the CVT to better understand the role of appraisals in shaping students’ thoughts during learning. Specifically, the current research both naturalistically and experimentally assessed which combinations of appraisals give rise to various dimensions of thoughts students experience throughout their time spent listening to a lecture as well as completing homework assignments post-lecture. An exploratory study (Study One) was conducted to naturalistically capture the relationship between different appraisals and phenomenological experiences during lecture. An experimental study (Study Two) prompted by data from Study One methodologically manipulated individuals’ appraisals at various points throughout a lecture. Study Two thus aimed to (a) empirically replicate how different combinations of appraisals generated during learning influence the types of thought one experiences during learning and (b) test the degree to which changing appraisals and thoughts during lecture impacts how one completes an assignment on the information they learned in the lecture. The aims of Study Two directly address the nature of online appraisals and thought during learning as well as momentary dynamics of thinking during learning. These studies
inform future research working to detect and respond to students’ patterns of thought through their appraisals to ultimately improve learning outcomes and learning experiences.

**Study One.** Study One was designed to answer the following question: Are patterns of achievement appraisals predictive of students’ experiencing (a) TUTs, (b) FMT, and (c) PCs with the learning material all during learning? Prior literature supports a relationship between students’ attention and appraisals; however, we do not yet know how definable thought dimensions that students commonly experience arise based on the appraisals they make during learning. Study One aimed to naturalistically measure students’ phenomenological experiences while learning from several lectures to uncover any relationships between appraisals and various types of thinking.

**Study Two.** Study Two was designed to answer two general questions. The first is: Can we experimentally manipulate momentary changes in students’ online appraisals to causally influence the phenomenological experiences they have? By asking this question, we can gain a clearer understanding of what directly shifts students’ appraisals during learning and thus their thought patterns. To do so, I recorded myself teaching a lecture so that I could completely control the conditions participants experienced, as well as have a comparable dataset to Study One (i.e., same instructor, same measurements) to test for causal relationships. Specifically, aspects of instructor speech were manipulated to direct students’ attention to the lecture content (e.g., a teacher saying “ok, now listen closely because this will be on your next exam”). Using such momentary manipulations might change students’ control and value appraisals at different points throughout learning. By manipulating students’ appraisals in such a way in addition to implementing an experience sampling protocol, I was able to determine causal relationships
between instructor speech, students’ appraisals, and various types of thinking. See Table 4 for an example of how participants’ thoughts may be related to manipulated patterns of appraisals.

<table>
<thead>
<tr>
<th>Value Appraisal</th>
<th>Control Appraisal</th>
<th>Proposed Dimensions of Thought</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive (success)</td>
<td>High</td>
<td>High rates of PCs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[due to positive value and high control]</td>
</tr>
<tr>
<td>Negative (failure)</td>
<td>High</td>
<td>Low rates of FMT (i.e., constrained thinking)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[due to negative value and high control]</td>
</tr>
<tr>
<td>Positive or Negative</td>
<td>Low</td>
<td>High rates of TUT and FMT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[primarily due to low control]</td>
</tr>
<tr>
<td>Low/None</td>
<td>High or Low</td>
<td>High rates of TUT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[primarily due to low/no value]</td>
</tr>
</tbody>
</table>

Additionally, Study Two addressed another question: How does the relationship between students’ appraisals and phenomenological experiences throughout lecture impact their performance on an assignment related to what they learned? The second proposed study will focus on the changing relationships between appraisals and thought dimensions while listening to a lecture and then applying that knowledge to an assignment. This study aims to better understand how students’ thoughts and appraisals during a lecture impact their academic performance on class activities and homework. To do so, a short writing assignment questioned students on concepts taught following the manipulations of instructor speech. By evaluating students’ performance on questions specific to causal shifts in control and value appraisals, I was able to clearly assess the effects of momentary experiences on learning outcomes. Additionally, students were similarly probed on their appraisals and thoughts throughout completion of the
assignment using an experience sampling protocol. In this way, I was able to map the dynamics of how students’ appraisals and thoughts change throughout a lecture onto how their appraisals and thoughts change during independent learning.

**Overall Study Aims.** Ultimately, this dissertation aims to apply the CVT to explain more than just student emotions because the basic tenets of the CVT have clear theoretical relations to the content and dynamics of what students think about during learning. By measuring both naturalistically and experimentally induced online phenomenological experiences over time and across learning activities, Studies One and Two provided results to address these gaps in the literature. All the results obtained in this dissertation not only expand our understanding of student learning, but also lay the groundwork for building an intelligent system to predict and respond to individuals’ thoughts and appraisals to improve learning outcomes in real time.

**Study One**

**Method**

**Participants**

Data was collected from students who were enrolled in an introductory psychology course taught by the author at a northeastern university in the United States. The study was ultimately collected via a required class activity implemented over the course of four lecture days. Data collection methods were approved by the university’s review board. Out of the 76 students enrolled in the course (Freshman [\(n = 38\)], Sophomore [\(n = 18\)], Junior [\(n = 13\)], Senior [\(n = 6\)], non-degree seeking [\(n = 1\)]; 94.7% non-majors), six students did not consent to their data being included in analyses resulting in analyzable data from 70 participants.

Given the naturalistic class setting for this study, various numbers of students were absent over the course of data collection or left class for various reasons (e.g., using the restroom,
doctor appointment, etc.) therefore resulting in missing data. Sixty-one students participated in data collection for the first lecture, 58 students participated in the second lecture, 56 participated in the third, and 49 participated in the last lecture. Out of the 70 total students who participated, only 36 students attended and participated in the study across all four lectures. Of those 36 students, 20 of them answered all of the prompts for each lecture.

**Class Organization**

The author teaches an introductory psychology course each semester of the academic year ranging between 30 to 130 students. The class consists of twice weekly 80-minute classes over the course of a 15-week semester. Students are typically freshman non-majors taking the course for credit to fulfill a graduation requirement in the social sciences cluster of electives. The course is taught in a lecture style with activities built into the slides each lecture. Activities range across the various subdisciplines in psychology (e.g., having students complete an operation span task when learning about working memory, doing a simple factor analysis when learning about contemporary approaches to personality, or watching videos of children performing various cognitive tasks and discussing their abilities when learning about developmental psychology). Throughout lecture, multiple-choice questions were also embedded into the slides to promote retrieval practice.

Data collection was completed over four lectures. The first lecture was on theories of motivation and historical approaches to personality psychology (e.g., Freud’s psychoanalytic theory). The second lecture was on contemporary approaches to personality psychology (e.g., a trait approach and the Big Five). The third lecture was an introduction to psychopathology research broadly and mood disorders (e.g., major depressive disorder and bipolar disorder). The
fourth and final lecture was an introduction to anxiety disorders (e.g., panic disorder and generalized anxiety disorder) and psychotic disorders (e.g., schizophrenia).

**Materials and Procedure**

The data were collected via class activities built in MentiMeter, which is an interactive presentation software that can be used in conjunction with an instructor’s lecture slides. MentiMeter is designed to incorporate various types of questions (e.g., multiple-choice, ratings, word clouds, etc.) into slides that audience members can answer on their smartphones. Their answers can then be anonymously presented on the screen depending on how MentiMeter is programmed (see [https://www.mentimeter.com](https://www.mentimeter.com) for more information). The instructor’s lecture slides were created using Keynote (Apple’s version of Microsoft PowerPoint); students saw alternating visuals between Keynote and MentiMeter depending on if the instructor was lecturing or presenting the class activity (i.e., data collection). Students could not advance through the activity in MentiMeter on their phones, only the instructor could advance through each slide for both the activity in MentiMeter and the lecture material in Keynote. The course content outlined in the lecture slides was based on David G. Myers and C. Nathan DeWall’s *Exploring Psychology in Modules* (11th Ed.) textbook.

Prior to the four data collection days, the study was presented to the students and all students partook in a practice day to become acquainted with MentiMeter. A collaborator came to the class and introduced the study opportunity to the students and explained the concepts of task-unrelated thought, freely-moving thought, personal connections, and appraisals so that students had an understanding of what they would be asked about in the study. The instructor left the room at that time to avoid any potential coercion for students to consent to their data to be used anonymously in future research. The teaching assistant passed out consent forms and
collected the forms when students were finished. The instructor then came back into the classroom and set up a practice session for students to better understand how to use MentiMeter and get used to answering questions through MentiMeter during class. All methods outlined below were used for the practice day, however the data were never used for analyses and were discarded.

**Pre-Lecture.** The first ten minutes of class time was reserved for pre-lecture data collection. Prior to each lecture, students entered the classroom to see MentiMeter presented on the projector screen. On the screen, they were prompted to log onto MentiMeter on their smartphones and enter a predetermined code to access the slideshow specific to data collection for each given lecture. Once all students arrived, the instructor advanced the presentation in MentiMeter and students saw a prompt on the projector screen to enter the last five digits of the student identification number (see slide 1 in Figure 1); this was done to link the students’ responses across all four data collection days. In the bottom right-hand corner of MentiMeter is a tracker that counts how many responses have been recorded, so the instructor could keep track of the students who had completed each question throughout the lecture. Once all responses were recorded in MentiMeter, the instructor advanced the presentation so that students saw six different ratings designed to assess their pre-lecture learning appraisals (see slide 2 in Figure 1). Students were asked to rate how much the following statements applied to them that day. Statements included “I have the impression that my learning during today's lecture will be under my control.” to assess control appraisals, “I believe the content from today's lecture will be valuable for me to learn.” to assess value appraisals, “I am confident that I will put a lot of effort into learning during today's lecture.” to assess effort appraisals, “I expect to master the content I will learn from today's lecture.” to assess expectancy appraisals, “I believe the content I will
learn from today's lecture is useful for me to know.” to assess utility value appraisals, and “I believe that being skilled at the psychology content that will be in today's lecture is important.” to assess attainment value appraisals. Students made their ratings for all six appraisals on a scale from 1 (strongly disagree) to 5 (strongly agree) on their smartphones. Results were hidden from students to keep their answers anonymous. Once all students answered the appraisal prompts, the instructor advanced MentiMeter to present instructions asking students to resume lecture and leave the window open on their phones. The instructor then pressed Command + Tab simultaneously to seamlessly alternate from MentiMeter to Keynote presentations on the projector screen to begin lecture.

Figure 1. Pre-Lecture Data Collection Design.

A.) Pre-Lecture
Lecture. Students answered three probes assessing their thoughts, appraisals, and affect throughout lecture. The exact probe timing was predetermined by the instructor before each lecture, however the first probe was presented in the first 10 to 30 minutes of lecture; the second probe was presented in the middle 30 to 50 minutes of lecture; the third probe was presented in the following 50 to 70 minutes of lecture.

To present each probe to students, the instructor used Command + Tab to swiftly switch from Keynote (see B in Figure 2) back to MentiMeter and advanced to the presentation so that the probe questions were presented on the projector screen as well as their smartphones (see C in Figure 2). This was done as part of the probe-caught study design to interrupt students in the midst of the thought they are experiencing in the moment; this causes them to reflect consciously on thoughts they may have been having but were unaware of. The first part of the probe prompted students to rate the nature of their thoughts just prior to the interruption. Students answered the following prompts on a scale from 1 (not at all) to 9 (completely) on their smartphones: task-unrelated thought was measured by asking “Were you thinking about something other than the lecture content?” freely-moving thought was measured by asking “Were your thoughts moving around freely from one thing to the next?” and personal connections were measured by asking “Did your thoughts contain a personal connection with the lecture content?” When the instructor saw that all students had answered the questions, she advanced the MentiMeter presentation. Given the different end-points for the constructs of interest to the study, the six probe questions during lecture had to be divided across three slides in MentiMeter. The second part of the probe prompted students to rate their ongoing learning appraisals during lecture from 1 (strongly disagree) to 5 (strongly agree). Control appraisals were assessed using the statement “I have the impression that learning the content from today's
lecture so far has been under my control.” and value appraisals were assessed using the statement “I believe the content I am learning from today's lecture so far has been valuable for me to learn.” Once all students answered the second part of the probe, the instructor advanced the presentation to measure students’ affective state on a scale from 1 (very negative) to 9 (very positive) using the question “How are you feeling right now in terms of valence (negative to positive)?” After all answers were submitted, the instructor advanced MentiMeter to present instructions asking students to resume lecture and leave the window open on their phones. All results were hidden from students to keep their answers anonymous. The instructor then switched back to the lecture slides. The sequence of probe questions described above was repeated three times throughout lecture.

Figure 2. Data Collection Design During Lecture.

B.) Lecture

C.) Probe (x3)
Post-Lecture. The last ten minutes of class time was reserved for post-lecture data collection. After the instructor reached the last lecture slide planned to be covered that day, she switched to MentiMeter and advanced the presentation to a prompt for students to put away their lecture notes but leave the window open on their phones (see slide 1 in Figure 3). Once all students put away their notes and had only their phones on their desks, the instructor advanced MentiMeter so that students saw six different ratings designed to assess their post-lecture learning appraisals (see slide 2 in Figure 3). Students were asked to rate how much the following statements applied to them that day. Statements included “I have the impression that my learning during today's lecture was under my control.” to assess control appraisals, “I believe the content from today's lecture was valuable for me to learn.” to assess value appraisals, “I am confident that I put a lot of effort into learning during today's lecture.” to assess effort appraisals, “I expect to master the content I learned from today's lecture.” to assess expectancy appraisals, “I believe the content I learned from today's lecture is useful for me to know.” to assess utility value appraisals, and “I believe that being skilled at the psychology content from today's lecture is important.” to assess attainment value appraisals. Students made their ratings for all six appraisals on a scale from 1 (strongly disagree) to 5 (strongly agree) on their smartphones. Results were hidden from students to keep their answers anonymous. After all students recorded their post-learning appraisals, the instructor advanced MentiMeter to display six multiple-choice questions one at a time (see slide 3 in Figure 3). Questions were written to assess students’ retention of the material they learned each day (not cumulatively). Students had four answer options. After all students submitted their answer for each question, the instructor shared the classes’ de-identified responses and briefly explained the correct answer to reinforce the information learned. This question sequence was repeated for all six questions. After all
questions were presented, answered, and explained, the instructor advanced MentiMeter to show a statement indicating class was dismissed (see slide 4 in Figure 3).

Figure 3. Post-Lecture Data Collection Design.

D.) Post-Lecture

Results

All analyses reported for Study One implemented linear mixed-effects regression models using the lme4 package in R (Bates, Maechler, Bolker, & Walker, 2015). All models included a random intercept for each participant to control for within-subject variability across their responses during lecture. However, crossed random effects were also used to take into account
that each participant (i.e., students) belonged to more than one upper-level grouping (i.e., lectures; see Figure 4). Therefore, the random intercept for each participant was crossed within a random intercept for each lecture. To avoid biasing the error variance, we used restricted maximum likelihood estimation (REML) with unstructured covariance. Type II Wald chi-square tests with a two-tailed $\alpha$ of .05 were conducted to test for model significance. We report both unstandardized ($b$) and standardized ($\beta$) estimates for partial slopes throughout the results. A few models resulted in a singular fit thus the complexity of random effects was reduced to include just a random intercept for participant; these models are indicated in each of the table notes.

*Figure 4. Crossed Random Effects for Study One*
Question One: Do Learning Appraisals Made Prior to Lecture Predict Thought Patterns during Lecture?

First, participants’ reports of each thought dimension during lecture were regressed onto each of their pre-lecture learning appraisals. Only participants’ pre-lecture appraisals of effort were significantly predictive of rates of task-unrelated thoughts experienced during lecture, $b = -.355$, $SE(b) = .119$, $\beta = -.151$, $\chi^2(1) = 8.89$, $p = .003$. This suggests that students who were more confident that they would put effort into learning the material from a given lecture prior to beginning class were reliably less likely to experience task-unrelated thoughts during lecture; conversely, students who did not believe they would put much effort into learning were more likely to experience thoughts unrelated to lecture while in class.

Freely-moving thought was significantly predicted by students’ pre-lecture appraisals of control ($b = -.264$, $SE(b) = .113$, $\beta = -.126$, $\chi^2(1) = 5.43$, $p = .020$) and utility value, $b = .286$, $SE(b) = .115$, $\beta = .120$, $\chi^2(1) = 6.23$, $p = .013$. Students who were under the impression that their learning of the lecture material would be under their control prior to beginning class were less likely to report having freely-moving thoughts during lecture (thus having constrained their thoughts to the information being learning). In contrast, students who felt they had less control over what they were going to learn about in a given lecture struggled to constrain their thoughts on the lecture material therefore experiencing more freely-moving thoughts. Additionally, students who believed that the lecture content would be useful for them to know prior to class were more likely to report experiencing freely-moving thought during lecture, presumably allowing themselves the flexibility in thinking to find utility in the information; students who did not believe that the lecture content would be useful for them likewise experienced more constrained, less flexible thoughts during class.
Pre-lecture appraisals of control, value, effort, utility value, and attainment value were all positively predictive of students’ reports of generating a personal connection with the lecture material during class (all $ps < .03$; see Table 5). Students were more likely to draw a connection between their personal life and the lecture content when they had previously appraised (a) their being in control of their learning, (b) the lecture content as more valuable as well as useful for them to know, (c) that they would put effort into learning the information from lecture, and (d) that being skilled in the information they would learn was important to them. Students may have generated personal connections when they believed the lecture content would be useful to them because their thoughts were more likely to be freely-moving thus giving students the cognitive flexibility to relate novel information to their personal lives without wandering off to task-unrelated information.
Table 5. Results for Question One

<table>
<thead>
<tr>
<th></th>
<th>Task-Unrelated Thought</th>
<th>Freely-Moving Thought</th>
<th>Personal Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>$b(\text{SE})$</td>
<td>$p$</td>
</tr>
<tr>
<td>Pre-Control</td>
<td>-.055</td>
<td>-.124(.124)</td>
<td>.317</td>
</tr>
<tr>
<td>Pre-Value</td>
<td>-.075</td>
<td>-.192(.122)</td>
<td>.115</td>
</tr>
<tr>
<td>Pre-Effort</td>
<td>-.151</td>
<td>-.355(.119)</td>
<td>.003*</td>
</tr>
<tr>
<td>Pre-Expectancy</td>
<td>-.093</td>
<td>-.218(.126)</td>
<td>.084</td>
</tr>
<tr>
<td>Pre-Utility Value</td>
<td>-.038</td>
<td>-.098(.126)</td>
<td>.437</td>
</tr>
<tr>
<td>Pre-Attainment Value</td>
<td>-.057</td>
<td>-.135(.121)</td>
<td>.264</td>
</tr>
</tbody>
</table>

*Note. Results listed here are mixed-effects linear regression models; models for (a) value, (b) effort, (c) expectancy, (d) utility value, and (e) attainment value predicting freely-moving thought initially had a singular fit and therefore the values posted here reflect a random effect just for participant rather than participant crossed within lecture.*
Question Two: Are Learning Appraisals and Affect during Lecture Related to Thought Patterns during Lecture?

Second, participants’ reports of each thought dimension during lecture were regressed on to their online appraisals and affect ratings. Experiences of task-unrelated thought during learning was significantly related to concurrent appraisals of control ($b = -.150$, $SE(b) = .107$, $\beta = -.126$, $\chi^2(1) = 9.53$, $p = .002$) and value ($b = -.490$, $SE(b) = .096$, $\beta = -.214$, $\chi^2(1) = 26.1$, $p < .001$) as well as affect during lecture, $b = -.201$, $SE(b) = .056$, $\beta = -.147$, $\chi^2(1) = 12.7$, $p < .001$ (see Table 6). These results suggest that students’ appraisals of their learning being out of their control, the lecture content as unvaluable for them to learn, and/or feelings of more negativity during learning were related to a higher likelihood of engaging in task-unrelated thoughts throughout the lecture. Only online appraisals of control were significantly related to experiences of freely-moving thought, such that students who felt as though their ongoing learning was in their control experienced thoughts that were presumably more constrained to the lecture content, $b = -.295$, $SE(b) = .096$, $\beta = -.146$, $\chi^2(1) = 9.45$, $p = .002$. Additionally, only online appraisals of value were significantly related to personal connections made during learning, $b = .815$, $SE(b) = .106$, $\beta = .332$, $\chi^2(1) = 59.3$, $p < .001$. Students who continually appraised the ongoing lecture content as valuable for them to learn reliably generated more personal connections during class.

See Table 6 for non-significant models. Patterns of the relationships between online appraisals of control and value along with experiences of freely-moving thought and personal connections during lecture are consistent the relationships between pre-lecture appraisals of control and value and online phenomenological experiences during class.
**Table 6. Results for Question Two**

<table>
<thead>
<tr>
<th></th>
<th>Task-Unrelated Thought</th>
<th>Freely-Moving Thought</th>
<th>Personal Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>$b(SE)$</td>
<td>$p$</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>-.150</td>
<td>-.331(.107)</td>
<td>.002*</td>
</tr>
<tr>
<td><strong>Value</strong></td>
<td>-.214</td>
<td>-.490(.096)</td>
<td>&lt; .001*</td>
</tr>
<tr>
<td><strong>Affect</strong></td>
<td>-.147</td>
<td>-.201(.056)</td>
<td>&lt; .001*</td>
</tr>
</tbody>
</table>

*Note.* Results listed here are mixed-effects linear regression models; model for freely moving thought predicting affect initially had a singular fit and therefore the values posted here reflect a random effect just for participant rather than participant crossed within lecture.
Question Three: Do Thought Patterns during Lecture Predict Learning Appraisals after Lecture?

Third, participants’ reports of each thought dimension and affect ratings during lecture were regressed onto each of their post-lecture learning appraisals. Experiences of task-unrelated thought during lecture significantly negatively predicted each of the post-lecture learning appraisals (all $ps < .01$; see Table 7). These results suggest that students’ awareness of their wandering task-unrelated thoughts during lecture left them feeling post-lecture as if they (a) did not have as much control over their learning, (b) did not believe what they had learned was valuable, (c) did not put a lot of effort into learning, (d) did not expect to master the material they had just learned, (e) did not believe what they had learned was useful, and (f) did not need to be skilled at what they had just learned about.

Experiences of freely-moving thought during lecture were significantly negatively predictive of post-learning appraisals of control ($b = -.034, SE(b) = .016, \beta = -.070, \chi^2(1) = 4.60$), value ($b = -.044, SE(b) = .019, \beta = -.090, \chi^2(1) = 5.21$), effort ($b = -.053, SE(b) = .019, \beta = -.103, \chi^2(1) = 7.58$), and expectancy, $b = -.031, SE(b) = .014, \beta = -.067, \chi^2(1) = 4.96$; all $ps < .04$. Though not as strong as task-unrelated thought, freely-moving thoughts similarly had an effect on post-learning appraisals such that students appraised their learning as overall more negative when their thoughts were not as constrained. Additionally, affect during lecture was significantly predictive of all post-learning appraisals, which suggests that negative affect experienced during learning may have led to students’ negative appraisals of their learning (all $ps < .04$). Conversely, the experience of personal connections during learning seemed to have a more positive effect on students’ post-learning appraisals. Personal connections significantly predicted higher appraisals of value ($b = .061, SE(b) = .015, \beta = .148, \chi^2(1) = 16.9$), effort ($b =
.057, SE(b) = .014, β = .129, χ²(1) = 15.6), utility value (b = .069, SE(b) = .015, β = .170, χ²(1) = 21.2), and attainment value, b = .048, SE(b) = .015, β = .112, χ²(1) = 10.4; all ps < .01.
Table 7. Results for Question Three

<table>
<thead>
<tr>
<th></th>
<th>Task-Unrelated Thought</th>
<th>Freely Moving Thought</th>
<th>Personal Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \beta )</td>
<td>( b(SE) )</td>
<td>( p )</td>
</tr>
<tr>
<td>Post-Control</td>
<td>-.083</td>
<td>-.037(.014)</td>
<td>.009*</td>
</tr>
<tr>
<td>Post-Value</td>
<td>-.170</td>
<td>-.076(.017)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Post-Effort</td>
<td>-.296</td>
<td>-.141(.017)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Post-Expectancy</td>
<td>-.115</td>
<td>-.049(.013)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Post-Utility Value</td>
<td>-.137</td>
<td>-.060(.017)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Post-Attainment Value</td>
<td>-.127</td>
<td>-.060(.017)</td>
<td>.001*</td>
</tr>
</tbody>
</table>

Note. Results listed here are mixed-effects linear regression models; model for freely moving thought predicting post-lecture appraisals for effort initially had a singular fit and therefore the values posted here reflect a random effect just for participant rather than participant crossed within lecture.

Table 7 contin.

<table>
<thead>
<tr>
<th></th>
<th>Affect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \beta )</td>
</tr>
<tr>
<td>Post-Control</td>
<td>.152</td>
</tr>
<tr>
<td>Post-Value</td>
<td>.097</td>
</tr>
<tr>
<td>Post-Effort</td>
<td>.166</td>
</tr>
<tr>
<td>Post-Expectancy</td>
<td>.065</td>
</tr>
<tr>
<td>Post-Utility Value</td>
<td>.129</td>
</tr>
<tr>
<td>Post-Attainment Value</td>
<td>.113</td>
</tr>
</tbody>
</table>
Question Four: Do Learning Appraisals and Thought Patterns Predict Academic Outcomes?

Lastly, daily class quiz scores and final course grades were regressed onto all pre-lecture appraisals, online learning appraisals, online phenomenological experiences, and post-lecture appraisals. Pre-lecture appraisals of control, utility value, and attainment value all positively predicted students’ class quiz performance such that the more in control of their learning that they felt prior to lecture, the more useful they felt the lecture content would be, and/or the more important they felt that being skilled at what they would be learning all resulted in higher quiz scores ($ps < .04$; see Table 8). During lecture, ongoing appraisals of the lecture content as being valuable and experience of personal connections with the learning material positively predicted class quiz performance ($ps < .02$); students who felt the information they were learning was continually valuable for them to learn and/or experienced drawing a connection with the lecture material and their personal lives performed better on the daily class quizzes. After lecture, appraisals of the learned lecture content as being valuable, useful, and important to attain all positively predicted daily class quiz performance ($ps < .01$).

<table>
<thead>
<tr>
<th>Table 8. Results for Question Four</th>
<th>Daily Class Quizzes</th>
<th>$\beta$</th>
<th>$b(SE)$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior to Lecture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Control</td>
<td>.097</td>
<td>.025(.012)</td>
<td>.035*</td>
<td></td>
</tr>
<tr>
<td>Pre-Value</td>
<td>.050</td>
<td>.014(.011)</td>
<td>.199</td>
<td></td>
</tr>
<tr>
<td>Pre-Effort</td>
<td>.050</td>
<td>.013(.011)</td>
<td>.239</td>
<td></td>
</tr>
<tr>
<td>Pre-Expectancy</td>
<td>-.032</td>
<td>-.008(.012)</td>
<td>.477</td>
<td></td>
</tr>
<tr>
<td>Pre-Utity Value</td>
<td>.141</td>
<td>.041(.011)</td>
<td>$&lt; .001^*$</td>
<td></td>
</tr>
<tr>
<td>Pre-Attainment Value</td>
<td>.126</td>
<td>.034(.011)</td>
<td>.002*</td>
<td></td>
</tr>
<tr>
<td>During Lecture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>.014</td>
<td>.003(.009)</td>
<td>.728</td>
<td></td>
</tr>
<tr>
<td>Value</td>
<td>.088</td>
<td>.021(.008)</td>
<td>.013*</td>
<td></td>
</tr>
</tbody>
</table>
### Discussion

These results provide novel evidence that academic appraisals are involved in more than just students’ emotions; the appraisals students make thus aid in broadly constructing their phenomenological experiences. Different combinations of appraisals appear to engender different types of thoughts related to learning. Interestingly, the patterns in which these combinations of appraisals shape students’ thoughts change dynamically over time. For example, pre-lecture appraisals are generally not very predictive of experiences of task-unrelated thoughts during learning (apart from assessing the amount of effort an individual plans to put into learning) but are very predictive of generating personal connections during learning (see Table 4 for original predictions and Table 9 for supporting results). However, appraisals made during learning and after learning show different relationships with the thoughts students have.

Task-unrelated thoughts are altogether negatively related to the appraisals students make (before, during, and after learning). Students who enter a classroom without intentions of exerting much effort into learning tend to experience more task-unrelated thoughts during learning without having a significant degree of freedom of movement around the topics they are
thinking about. For instance, Student A does not plan on putting a lot of effort into listening to their psychology lecture about implicit bias. They may be thinking about finding a new roommate and posting ads on Craigslist (rather than focusing on the lecture content) while also not having freely moving thoughts. Instead of also thinking about other topics like what they are going to have for dinner and their plans for over the weekend, Student A’s thoughts stay relatively constrained on finding a new roommate.

Students who enter a classroom without feeling as if they are in control of their own learning are more likely to experience freely-moving thoughts that do not tend to include a personal connection during learning. These thoughts might consist of a student who attempts to understand the learning material by aimlessly accessing information from memory without actually connecting anything to their personal lives. For example, Student B believes their psychology professor makes the course content too difficult for them to adequately learn. When they are attending a lecture on implicit bias, they might experience thoughts ranging from the 2015 presidential debate in which Hillary Clinton first mentioned implicit bias in the mainstream media to individuals’ tendency to ignore black pets available for adoption by choosing pets with lighter-colored fur to Northerners aversion to Southerners (and vice versa) without relating their own subtle racial experiences to the definition of implicit bias.

In general, freely-moving thought does not appear to be related to task-unrelated thought. Additionally, patterns of appraisals predicting both freely-moving thought and task-unrelated thought differ, such that pre-lecture appraisals concerning the utility value of what a student is going to learn positively predicts both freely-moving thought and personally connective thought. Thus, when a student enters a classroom believing that what they are going to learn about that day will be useful for them to know in the future are more likely to experience freely-moving
thoughts during learning that do include a personal connection. For instance, Student C who is pursuing a justice studies major may find learning about research on implicit bias in their psychology course to be useful for their career. Therefore, they may have similarly freely-moving thoughts like Student B but also connect the course content to a crime case they worked on during their summer internship as an investigative specialist.

All of these examples, however, also rely on the appraisals students continually make throughout learning. Students who may initially appraise their effort as low prior to lecture may begin to appraise both their control over their learning and the value of the information being learned as low during a lecture, ultimately resulting in increased task-unrelated thought. Experiences of freely-moving thought are similarly dependent upon low appraisals of control both prior to and during learning. The generation of connections with course content and students’ personal lives are also significantly related to high appraisals of value both before and during lecture.

| Table 9. Results of Study One regarding Hypotheses about Phenomenological Experiences |
|-----------------------------------|----------------------------------|------------------------|------------------------------------------------|
| **Appraisals** | **Proposed Dimensions of Thought** | **Results** | |
| Value      | Control | High rates of PCs | **Supported; high value appraisals predicted more reports of PCs** |
| Positive (Success) | High | Low rates of FMT | **Supported; high control appraisals predicted less reports of FMT** |
| Negative (Failure) | High | High rates of TUT and FMT | **Supported; low control appraisals predicted more reports of both TUT and FMT** |
Additionally, phenomenological experiences during learning are significantly predictive of students’ post-lecture appraisals therefore suggesting the existence of a reciprocal relationship between cognitive appraisals made and the types of thoughts we experience during learning. For example, task-unrelated thought was only predicted by pre-learning appraisals of effort yet negatively predicted all post-learning appraisals measured in the current study (i.e., control, value, effort, expectancy, utility value, and attainment value). Students’ experiences of task-unrelated thoughts are therefore compelling enough to foster appraisals related to unsuccessful learning after a lecture. Conversely, results show almost identical patterns of relationships between pre-learning appraisals and experiences of personal connections during learning as well as personal connections during learning and post-learning appraisals. Students who begin learning with making appraisals related to successful learning outcomes not only increase their likelihood of generating personal connections but also those personal connections further encourage post-learning appraisals that positively assess the depth of their retention. Interestingly, results show that the only significant models for predicting learning outcomes on the daily class quizzes are positive (e.g., high pre-lecture appraisals of control and value, high appraisals of value during lecture, experiences of personal connections, and high post-lecture appraisals of value). Ultimately, these positive relationships suggest that students’ confidence in their learning and personal connections made during lecture are significantly associated with positive learning outcomes rather than task-unrelated thoughts and related unsuccessful learning.
appraisals. This naturalistic study has provided invaluable insight into the dynamics of cognitive appraisals, thinking, and learning outcomes, however there is much to be done in terms of understanding the various conditions that manipulate students’ appraisals and thought types.

**Study Two**

Study Two followed up on Study One by taking an empirical approach to manipulate individuals’ achievement appraisals using instructor speech. Specifically, Study Two tested whether we can experimentally manipulate momentary changes in students’ online appraisals to induce certain phenomenological experiences during learning. For example, Study One clearly demonstrated the relationships between appraisals prior to, during, and after a lecture with students’ thoughts and academic performance. Therefore, it may be the case that we can experimentally induce such relationships to better understand the causal role that appraisals play in shaping students’ learning experiences more broadly and likewise corroborate the naturalistic patterns found in Study One. Additionally, Study Two tested whether students’ appraisals and phenomenological experiences throughout lecture learning have an impact on their ability to complete a related assignment after lecture. Answering these questions has provided us with a clearer understanding of how appraisals may influence students’ learning by impacting how and what they think about as well as their independent work.

**Method**

**Participants**

Data was collected from 282 ($M_{age} = 19.24$; age range: 18-59; 78.34% women; 89.17% White/Caucasian; 96.39% native English speakers) participants recruited via SONA, an online recruitment site used at many universities. Those who participated received credit for a course
requirement. Participants were randomly assigned to one of four counterbalanced conditions created using a Latin Square Design (see Table 10) prior to beginning the experiment such that the samples are even across conditions ($n_A = 71; n_B = 71, n_C = 68, n_D = 70$). Each counterbalance exposed participants to four different appraisal conditions at various points in the lecture. To ensure sufficient power, we collected a sample of at least 300 participants to account for any unforeseen issues with data collection.

<table>
<thead>
<tr>
<th>Counterbalance</th>
<th>Probe Number</th>
<th>One</th>
<th>Two</th>
<th>Three</th>
<th>Four</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>High control, high negative value</td>
<td>Low control, positive or negative value</td>
<td>High control, high positive value</td>
<td>High or low control, low/no value</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>High or low control, low/no value</td>
<td>High control, high negative value</td>
<td>Low control, positive or negative value</td>
<td>High control, high positive value</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>High control, high positive value</td>
<td>High or low control, low/no value</td>
<td>High control, high negative value</td>
<td>Low control, positive or negative value</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Low control, positive or negative value</td>
<td>High control, high positive value</td>
<td>High or low control, low/no value</td>
<td>High control, high negative value</td>
<td></td>
</tr>
</tbody>
</table>

**Materials**

**Lecture video.** A lecture taught by the author was video-recorded to use for the study.

The lecture was taught at the level of an introductory psychology course in college and instructed participants on consciousness and thinking, including a dual-process model of consciousness, concepts and categories, heuristics and problem solving, creativity, and sleeping and dreaming.
The instructor’s lecture slides were created using Keynote. The course content outlined in the lecture slides was based on David G. Myers and C. Nathan DeWall’s Exploring Psychology in Modules (11th Ed.) textbook. The lecture lasted 39 minutes and 53 seconds split into the following increments in order: 7:47, 10:16, 8:05, 10:16, 3:29. Probes assessing appraisals, thoughts, and emotions occurred in between each video clip.

The appraisal manipulations occurred at four points in the lecture in which the instructor was about to teach information that participants would be required to write about in the post-lecture assignment. Specifically, the instructor said a statement intended to capture students’ attention so that they generated a respective set of appraisals (See Table 1). Then, afterward, the instructor would lecture on a topic that was directly asked about on the post-lecture assignment. After the information was sufficiently covered in lecture, the video was automatically paused, and participants answered a thought probe. Based on this design, we were able to link (a) the manipulation with the appraisal generation collected during the probe, (b) the appraisal generation collected during the probe and the thoughts and emotions participants reported experiencing during the probe, and (c) the thoughts participants reported experiencing during the probe and retention of learned information after lecture.

**Control manipulation.** Appraisals of control were manipulated in two different ways: in either a high or low fashion. Control appraisals were manipulated through instructor speech directing students’ attention toward the difficulty (low control) or ease (high control) in learning the information taught just after the instructor initiated the appraisal generation. Specifically, the instructor said “This next piece of information is really easy to learn…” to manipulate students’ appraisals of high control or “This next piece of information is really hard to learn…” to manipulate students’ appraisals of low control. Sharing with participants that the information
being presented is difficult was done to evoke feelings of low control because the individual
would not know whether they have the ability to fully understand the information. Sharing with
participants that the information being presented is easy was done to evoke empowered feelings,
such that the individual would know they can retain and remember the information.

**Value manipulation.** Appraisals of value were manipulated in three different ways
amongst the high/low control conditions: high-positive (success), high-negative (failure), and
low/no value. Value appraisals were manipulated through instructor speech directing students'
attention toward achieving success (high-positive), avoiding failure (high-negative), or moving
on with the lecture (low/no value). Specifically, high-positive value was manipulated when the
instructor said "pay attention so you get this right on the homework assignment" before
describing a concept that participants were going to be asked about on the assignment. This
manipulation was designed to direct participants’ attention to the lecture and increase the value
of what they are about to learn by emphasizing their academic success in mastering the
information that comes next. High-negative value was manipulated when the instructor said "pay
attention so you don’t get this wrong on your homework assignment" before describing a
concept that participants were going to be asked about on the assignment. This manipulation was
designed to direct participants’ attention to the lecture and increase the value of what they are
about to learn by emphasizing their need to avoid failure in learning the information that comes
next. Low/no value was manipulated by the instructor saying "but it is not all that important for
you to pay attention to" before describing a concept that participants were going to be asked
about on the assignment. This manipulation was designed to not intentionally direct participants’
attention to specific information and therefore not emphasize any value in learning the
information that comes next.
Table 11. Momentary Appraisal Manipulations

<table>
<thead>
<tr>
<th>Value Appraisal</th>
<th>Control Appraisal</th>
<th>Appraisal Manipulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive (success)</td>
<td>High</td>
<td>“This next piece of information is really easy to learn but pay attention so you get this right on your homework assignment.”</td>
</tr>
<tr>
<td>Negative (failure)</td>
<td>High</td>
<td>“This next piece of information is really easy to learn, so pay attention so you don’t get this wrong on your homework assignment.”</td>
</tr>
<tr>
<td>Positive or Negative</td>
<td>Low</td>
<td>“This next piece of information is really hard to learn but pay attention.”</td>
</tr>
<tr>
<td>Low/None</td>
<td>High or Low</td>
<td>“Let’s move on to the next piece of information but it is not all that important for you to pay attention to.”</td>
</tr>
</tbody>
</table>

**Probes.** Probes briefly interrupted participants throughout learning. There were four probes placed throughout the lecture video. Probes measured the same metrics as Study One with the addition of assessing the four distinct emotion states that Pekrun (2006) hypothesized were experienced as a result of appraisals made during learning (i.e., activity emotions; see Table 3). Participants answered the following prompts on a scale from 1 (*not at all*) to 9 (*completely*) on their computers: task-unrelated thought was measured by asking “Were you thinking about something other than the lecture content?” freely-moving thought was measured by asking “Were your thoughts moving around freely from one thing to the next?” personal connections were measured by asking “Did your thoughts contain a personal connection with the lecture content?” enjoyment was measured by asking “Were you feeling enjoyment?” anger was measured by asking “Were you feeling anger?” frustration was measured by asking “Were you feeling frustration?” and boredom was measured by asking “Were you feeling boredom?” Participants were asked to rate their ongoing learning appraisals during lecture from 1 (*strongly disagree*) to 5 (*strongly agree*) to validate the control and value manipulations and replicate
Study One. Control appraisals were assessed by the participant rating the degree to which they agreed with the statement “I have the impression that learning the content from today's lecture so far has been under my control.” and value appraisals were assessed by the participant rating the degree to which they agreed with the statement “I believe the content I am learning from today's lecture so far has been valuable for me to learn.” Lastly, probes asked participants to rate their affective state on a scale from 1 (very negative) to 9 (very positive) using the question “How are you feeling right now in terms of valence (negative to positive)?”

Post-lecture assignment. Participants were given an assignment to complete that mimicked a typical college-level homework assignment. Before, during, and just after participants completed the post-lecture assignment, their control and value appraisals were assessed. The assignment asked participants to answer four short answer questions and eight multiple-choice questions to assess their learning. Specifically, the short answer questions assessed students’ learning of the information just prior to the probe. The questions on the assignment used language directly from the lecture to avoid participants relying on the internet to search for answers. See Appendix 1 for a copy of the assignment. The author and a research assistant independently rated 10% of participants’ short answer question responses based on the grading criteria outlined in the assignment. Interrater reliability measures assessed scores for all four questions using Cohen's Kappa statistics. Interrater reliability was moderate (κ = .579).

After acceptable interrater reliability was obtained, the author scored the remaining data.

Procedure

Interested participants chose the study listed online on SONA. They first read a description of the study, the risks and benefits of completing it, and the compensation they would receive for completing the study (i.e., course credit). If they consented to participate, they
indicated so on an online form and read instructions on how to complete the study. Participants were informed that they will be watching a psychology lecture and completing a related homework assignment. They read short descriptions of what appraisals, TUT, FMT, and PCs are and confirmed they understood each concept before they began.

Participants were asked to pay attention to the entire lecture and take notes as if they were a student in the class and were being tested on the material. They were told that after they watched the lecture video, they would complete a short homework assignment based on what they learned from the lecture. Participants were encouraged to use their notes to complete the assignment and were told that their performance on the assignment would be graded.

Before they watched the lecture, participants’ pre-lecture learning appraisals were assessed just like the Study One. Participants answered the following prompts on a scale from 1 (strongly disagree) to 5 (strongly agree): “I have the impression that my learning during this lecture will be under my control.” to assess control appraisals, “I believe the content from this lecture will be valuable for me to learn.” to assess value appraisals, “I am confident that I will put a lot of effort into learning during this lecture.” to assess effort appraisals, “I expect to master the content I will learn from this lecture.” to assess expectancy appraisals, “I believe the content I will learn from this lecture is useful for me to know.” to assess utility value appraisals, and “I believe that being skilled at the psychology content that will be in this lecture is important.” to assess attainment value appraisals. After they made these appraisals, they began to watch the lecture.

Four times throughout the lecture, the instructor said one of the appraisal manipulations (see Table 1) and then described a concept. After the instructor provided the description, the video automatically paused and participants were briefly interrupted and probed on their control
and value appraisals, task-unrelated thought, freely-moving thought, personal connections, enjoyment, anger, frustration, boredom, and general affective state. After participants answered the probes, the lecture video automatically resumed, and they continued taking notes.

After participants finished watching the lecture, they answered the following prompts on a scale from 1 (strongly disagree) to 5 (strongly agree): “I have the impression that my learning during this lecture was under my control.” to assess control appraisals, “I believe the content from this lecture was valuable for me to learn.” to assess value appraisals, “I am confident that I put a lot of effort into learning during this lecture.” to assess effort appraisals, “I expect to master the content I learned from this lecture.” to assess expectancy appraisals, “I believe the content I learned from this lecture is useful for me to know.” to assess utility value appraisals, and “I believe that being skilled at the psychology content from this lecture is important.” to assess attainment value appraisals.

After they made these appraisals, they began the portion of the study where they completed the short essay assignment. Before they began writing, they answered the following prompts on a scale from 1 (strongly disagree) to 5 (strongly agree): “I have the impression that my performance on this essay assignment will be under my control.” to assess control appraisals, “I believe that putting the material from the lecture into my own words in this essay assignment will be valuable for me to do.” to assess value appraisals. Participants then began writing.

Halfway throughout completion of the post-lecture assignment, participants were interrupted to answer the following prompts on a scale from 1 (strongly disagree) to 5 (strongly agree) using the following two statements: “I have the impression that my performance on this homework assignment will be under my control so far.” and “I believe that putting the material from the lecture into my own words in this homework assignment will be valuable for me to do
so far.” Participants then finished answering the remaining half of the questions on the assignment.

After they finished and submitted their assignments, participants answered the following prompts on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*): “I have the impression that my performance on this homework assignment was under my control.” to assess control appraisals, “I believe that putting the material from the lecture into my own words in this homework assignment was valuable for me to do.” to assess value appraisals. Participants also answered a brief set of questions asking (a) whether they experienced audio troubles when listening to the lecture (Yes/No), (b) whether they used the internet to search for answers on the homework assignment (Yes/No), (c) to rate how interested they were in the content of the lecture on a scale from 1 (*not at all interested*) to 5 (*incredibly interested*), and (d) to rate their prior knowledge on the content of the lecture on a scale from 1 (*knew nothing or almost nothing*) to 5 (*knew everything or almost everything*). They then answered some demographic questions. Lastly, they read a short description of the study debriefing them on the purpose of the experiment and left the website to receive compensation.

**Results**

Analyses reported here for Study Two implemented logistic mixed-effects regression models using the *lme4* package in R (Bates, Maechler, Bolker, & Walker, 2015). Similar to Study One, all models included a random intercept for each participant to control for within-subject variability across their multiple responses collected as they were watching the lecture. Restricted maximum likelihood estimation (REML) with unstructured covariance was also used. Model significance was assessed using type II Wald chi-square tests with a two-tailed $\alpha$ of .05. Additionally, Pearson’s correlation analyses were conducted to further evaluate the results for
Study Two. Prior to calculating the correlations, data were aggregated by individual such that each participants’ reported values across all four probes were averaged.

**Question One: Do Manipulations in Instructor Speech cause Corresponding Appraisal Patterns for Students Learning during a Lecture?**

Two logistic mixed-effects regression models were conducted to test whether manipulations in instructor speech changed the control and value appraisals participants made as they were watching the online lecture. Both models included counterbalance as a predictor variable to control for any potential differences across the four counterbalanced conditions.

Control and value appraisals were thus regressed onto appraisal condition (represented by the following dummy-coding scheme: 1 = high control and high negative value, 2 = low control and positive or negative value, 3 = high control and high positive value, 4 = high or low control and low/no value; see Table 11 for a review on the appraisal manipulations). Overall, both models were non-significant suggesting the appraisal manipulations were not successful; appraisal condition did not predict participants’ reported control ($\chi^2(1) = 1.60, p = .660$) or value appraisals, $\chi^2(1) = 4.86, p = .182$. Control appraisals provided after the instructor emphasized the information would be easy to learn (high control; $M = 3.70, SD = 0.93$; $M = 3.73, SD = 0.94$) were not statistically higher than appraisals provided after the instructor mentioned that they would be moving on (high or low control; $M = 3.67, SD = 0.98$) or that the information would be difficult to learn (low control; $M = 3.68, SD = 1.04$). Likewise, value appraisals provided after the instructor oriented students to pay attention by emphasizing they should either avoid getting a question on a later homework assignment wrong (high negative value; $M = 3.42, SD = 1.07$) or ensure they get a question right (high positive value; $M = 3.53, SD = 0.96$) were not statistically higher than when the instructor said “but pay attention” (positive or negative value; $M = 3.47, SD = 0.94$).
= 1.04) or “but it is not all that important for you to pay attention to” (low/no value; $M = 3.47$, $SD = 0.98$). Additionally, counterbalance did not significantly predict control ($\chi^2(1) = .598, p = .897$) or value appraisals ($\chi^2(1) = 2.19, p = .535$), suggesting there were no statistical differences in participants’ appraisals across the four conditions they could have been randomly assigned to.

See Table 12 for descriptive statistics.

<table>
<thead>
<tr>
<th>Online Measure</th>
<th>High control, high negative value</th>
<th>Low control, positive or negative value</th>
<th>High control, high positive value</th>
<th>High or low control, low/no value</th>
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<tbody>
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<td>Control</td>
<td>3.70(0.93)</td>
<td>3.68(1.04)</td>
<td>3.73(0.94)</td>
<td>3.67(0.98)</td>
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<tr>
<td>Value</td>
<td>3.42(1.07)</td>
<td>3.47(1.04)</td>
<td>3.53(0.96)</td>
<td>3.47(0.98)</td>
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<tr>
<td>Task-Unrelated Thought</td>
<td>5.36(2.35)</td>
<td>5.57(2.23)</td>
<td>5.44(2.19)</td>
<td>5.56(2.19)</td>
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<tr>
<td>Freely-Moving Thought</td>
<td>5.21(2.12)</td>
<td>5.39(2.04)</td>
<td>5.31(1.98)</td>
<td>5.29(2.00)</td>
</tr>
<tr>
<td>Personal Connections</td>
<td>4.09(2.22)</td>
<td>4.25(2.21)</td>
<td>4.31(2.27)</td>
<td>4.21(2.16)</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>3.70(2.05)</td>
<td>3.54(2.01)</td>
<td>3.54(1.95)</td>
<td>3.47(1.95)</td>
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<tr>
<td>Anger</td>
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<td>1.50(1.14)</td>
<td>1.48(1.08)</td>
<td>1.52(1.20)</td>
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<td>Frustration</td>
<td>2.06(1.70)</td>
<td>2.04(1.73)</td>
<td>2.07(1.63)</td>
<td>2.04(1.62)</td>
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<td>Boredom</td>
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<td>Affect</td>
<td>5.15(1.22)</td>
<td>5.12(1.24)</td>
<td>5.18(1.20)</td>
<td>5.23(1.21)</td>
</tr>
</tbody>
</table>

**Table 12. Descriptive Statistics Across Appraisal Manipulations [$M(SD)$]**

**Question Two: Do Manipulations in Instructor Speech predict Students’ Phenomenological Experiences during Lecture Learning?**

Eight additional logistic mixed-effects regression models were conducted to similarly test whether manipulations in instructor speech changed the phenomenological experiences participants reported having as they were watching the online lecture. Each model also controlled for potential differences in phenomenological experiences across counterbalanced conditions; each counterbalanced condition was not different from the other except for the order of the appraisal manipulations (see Table 10). Overall, all models for predicting phenomenology from
the appraisal conditions were non-significant \((ps > .05)\), suggesting that manipulations in instructor speech not only had no reliable effect on participants’ appraisals but also their thoughts and emotions during learning. There were also largely no effects of counterbalance on participants’ phenomenological experiences either \((ps > .05)\). However, there were some unanticipated differences in TUT \((\chi^2(1) = 13.8, p = .003)\) and feelings of boredom across the counterbalanced conditions, \(\chi^2(1) = 16.4, p = .001\). To further assess these differences, estimated marginal means were calculated using the \textit{emmeans} package in R \((\text{Lenth}, 2023)\) to extract mean values adjusted for variation across the different levels of predictor variables in the model. Task-unrelated thought was experienced statistically less often in counterbalance B \((EMM = 4.94, SE = .200)\) compared to counterbalances C \((EMM = 5.80, SE = .201, t(322) = -3.07, p = .012)\) and D, \(EMM = 5.85, SE = .202, t(296) = -3.20, p = .008\). Reported feelings of boredom were also statistically lower in counterbalance B \((EMM = 4.55, SE = .229)\) compared to counterbalances A \((EMM = 5.58, SE = .235, t(290) = 3.16, p = .010)\), C \((EMM = 5.71, SE = .228, t(345) = -3.65, p = .002)\), and D, \(EMM = 5.49, SE = .231, t(305) = -2.89, p = .021\). The Hampel Filter (a method of detecting outliers using an interval created by ± three absolute deviations away from the median) was calculated on data for TUT and boredom to see whether outliers may be responsible for the effects of counterbalance B on participants’ phenomenological experiences. There were no outliers detected, suggesting that counterbalance B had an extraneous effect on lowering participants’ reports of TUT and boredom. See Table 13 for raw means and standard deviations.

\begin{table}[h]
\centering
\caption{Descriptive Statistics Across Counterbalanced Conditions \([M(SD)]\)}
\begin{tabular}{lcccc}
\hline
Online Measure & A & B & C & D \\
\hline
Control & 3.71(0.93) & 3.67(0.97) & 3.64(1.06) & 3.76(0.91) \\
Value & 3.45(1.03) & 3.58(0.93) & 3.37(1.05) & 3.49(1.02) \\
Task-Unrelated Thought & 5.33(2.20) & 5.06(2.18) & 5.69(2.19) & 5.86(2.31) \\
Freely-Moving Thought & 5.15(2.01) & 4.93(1.96) & 5.38(2.06) & 5.75(2.02) \\
\hline
\end{tabular}
\end{table}
Question Three: Do Students’ Appraisals and Phenomenological Experiences during Lecture Learning predict their Appraisals Experienced Throughout the Completion of Related Independent Work and their Academic Performance?

Correlation analyses were conducted to assess these relationships (see Table 14). Given the large number of correlation analyses needed, $p$-values were adjusted using the Hochberg procedure (Hochberg, 1988) to control for Type I error inflation. The Hochberg procedure was chosen because it is less conservative than the traditionally-used Bonferroni correction (Bonferroni, 1936) but still limits the probability of making a false discovery. All analyses reported below were conducted independent of the appraisal manipulation.

**Appraisals and Phenomenological Experiences During Learning and Appraisals During Independent Work**

Overall, results suggest that control and value appraisals made while listening to a lecture were positively related to control and value appraisals made later while completing an assignment based on the lecture ($rs \geq .275; ps < .05$); participants who felt they were in control of their learning and valued the information they were learning throughout lecture tended to similarly report feeling in control of and valuing time spent on completing a related assignment. Reports of task-unrelated thought throughout lecture learning largely negatively predicted control and value appraisals made later while completing the assignment ($rs \leq -.172; ps < .05$) with the exception of pre-homework control ($r(279) = -.119; p > .05$); reports of freely-moving
thought and personal connections made during learning did not relate to later appraisals made while completing the assignment \( (ps > .05) \). Both distinct emotion states and general affect experienced during learning were significantly related to appraisals made while completing the assignment. Affect \( (rs \geq .183; ps < .05) \) and experiences of enjoyment \( (rs \geq .161; ps < .05) \) during learning were overall positively related to feeling in control of and valuing time spent completing the assignment. The greater the positive affect and enjoyment that participants felt during learning, the more control and value they tended to appraise regarding the assignment. Experiences of anger \( (rs \leq -.171; ps < .05) \), frustration \( (rs \leq -.147; ps < .05) \), and boredom \( (rs \leq -.171; ps < .05) \) during learning were largely negatively related to control and value appraisals made while completing the assignment, suggesting that participants who felt angry, frustrated, and bored during learning tended to feel less in control of their work as well as tended to place less value in completing the assignment. Overall, these results suggest that the phenomenological experiences students routinely have during learning leave residual influence over how they appraise their own abilities and the benefit of learning when doing independent work.

**Appraisals and Phenomenological Experiences During Learning and Academic Performance on Independent Work**

Correlation analyses were also conducted to assess the relationship between the appraisals, thoughts, and affect that participants reported experiencing during lecture and their academic performance on a post-lecture assignment (see Table 14). Both measures assessing post-lecture academic performance (multiple-choice and short answer essays) were significantly related to participants’ appraisals and phenomenological experiences during lecture learning. In particular, high control and value appraisals were positively related to better performance on the multiple-choice questions and short-answer essays \( (rs > .200, ps < .05) \). The more in control of
their learning students felt and the more value students placed in learning, the better they tended to do on learning assessments. Experiences of TUT and FMT were both negatively related to academic performance, such that greater the rates of TUT and FMT during lecture, the lower the scores on multiple-choice questions and short-answer essays tended to be ($rs < .200, ps < .05$). Negative correlations between TUT and academic performance are seen routinely in the literature (see Wong, Smith, McGrath, Flynn, and Mills, 2022). In this case, FMT may similarly be negatively related to academic performance if students’ thoughts are freely moving because they are trying to mentally organize the new incoming information or feeling some negative emotions along with trying to learn without focusing on what the instructor is saying.

Experiences of negative emotions (anger, frustration, and boredom) during lecture were also largely negatively correlated with academic performance after lecture ($rs < .220, ps < .05$). The more participants experienced anger and boredom during lecture, the worse they tended to do on the multiple-choice questions and short answer essays. Interestingly, the more frustrated participants felt, the worse they tended to do on the short answer essays ($r = -.169, p = .031$) but not the multiple-choice questions, $r = -.145, p = .084$. Frustrated feelings may be less related to performance on multiple-choice questions given they tend to be easier and therefore students may be able to work through their negative emotions to successfully answer the question better. Additionally, multiple-choice questions reflect recognition processes which are less effortful in comparison to the retrieval processes required in short answer responses (McDaniel, Roediger, & McDermott, 2007).
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<td>13. Mid-Homework Control</td>
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<td>15. Post-Homework Control</td>
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<td>-0.146</td>
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<td>0.339</td>
<td>0.325</td>
<td>0.276</td>
<td>0.629</td>
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</table>

*Note. P*-values were adjusted using Hochberg’s (1988) step-up procedure and then compared to an α-value of .05; correlations **bolded** indicate statistical significance.
Discussion

Study Two sought to experimentally manipulate control and value appraisals during learning as well as test how appraisals and phenomenological experiences during online learning impact students’ perceptions of their academic performance on related independent work. Results showed that our use of subtle speech manipulations to evoke certain patterns of control and value appraisals was not successful. However, results do highlight how appraisals and students’ phenomenological experiences during learning cast subsequent influences on students’ perceptions of their own academic performance in an online learning environment.

As previously mentioned, manipulating control and value appraisals based on messages an instructor delivers to students did not work as hypothesized. This could be due to a number of reasons. First, the manipulation could have been too subtle. Oftentimes instructors greatly emphasize when a particular bit of content from lecture will be on a later assignment or exam to alert students’ attention; it may be the case that simply mentioning this in passing is not enough to underscore the importance of the content and therefore not enough to induce respective appraisals. All four of the appraisal manipulations were recorded using the same tone and speed of voice to the best of the author’s ability to control for any unforeseen confounding differences between the statements (see Table 10). In doing so, each manipulation might not have been powerful or realistic enough to generate corresponding appraisals in participants. Second, an online learning medium may not have been sufficient to manipulate control and value appraisals. For example, it is widely supported that students struggle to pay attention during online learning (Biwer, Wiradhany, Oude Egbrink, Hospers, Wasenitz, Jansen, & De Bruin, 2021; Lemay, Bazelais, & Doleck, 2021). Kee (2021) even noted that graduate students reported feeling less in control over their capacity to learn when forced to switch to online learning during the COVID-
19 pandemic. Furthermore, both students and instructors are consciously aware of the struggle of remote learning given it is less efficacious than in-person learning (Almahasees, Mohsen, & Amin, 2021). Perhaps there would be an effect of instructor speech on students’ generation of achievement appraisals with in-person learning. Last, there may have been no effect of appraisal manipulation because the data was collected from students who were granted participation credit for a course rather than from those who were actually learning in a course for a grade. Their learning in this case may have been superficial and thus the manipulations did not accurately evoke appraisals that might have been true with genuine learning.

Regardless of the appraisal manipulations, participants still assessed how in control they felt about their learning progress and how valuable they felt learning the information was at several time points throughout the experiment. The appraisals measured passively throughout lecture learning and completion of a post-lecture assignment revealed some meaningful knowledge pertaining to the student experience. For example, reports of control and value appraisals made when watching the online lecture significantly and positively correlated with pre-, mid-, and post-homework control and value appraisals at a moderate level of strength (i.e., between $r = .275$ and $r = .532$). These correlational relationships suggest that the appraisals a student makes when learning specific material tend to remain consistent when subsequently studying and applying that material outside the classroom; this result highlights the potential benefit of initiating high control and value appraisals as well as the potential detriment of initially low perceptions of control and value in terms of how a student phenomenologically feels when completing independent work. These data thus support the idea that students who feel as if they have low control over their learning and/or do not find much value in what they are learning in the classroom may feel similarly when trying to study and apply the information on their own
time. Alternatively, if students do like a topic or course, they may appraise their control and value as high both during learning and while doing homework. Goetz and colleagues (2012) found a similar pattern when using inventories to measure achievement emotions stemming from learning in the classroom and from completing homework independently. They found that while achievement emotions differed between classroom learning and independent work, there were still some significant positive correlations between the degree of achievement emotions experienced. For example, enjoyment experienced while learning mathematics in the classroom was highly positively correlated to enjoyment experienced while completing mathematics homework (Goetz et al., 2012). While most related research has taken a longitudinal perspective on understanding how control and value appraisals change over the course of several months (e.g., Putwain et al., 2018), the current findings correspond with past work that has investigated patterns of appraisals and emotions over a shorter period of time.

Results of the current study revealed that reported emotions during online lecture learning were related to achievement appraisals made while completing independent work. Specifically, experiences of greater positive affect and enjoyment while watching the lecture were related to higher feelings of control and value when completing the assignment (for related research, see Simonton & Garn, 2020). Conversely, experiences of greater anger, frustration, and boredom while watching the lecture were related to lower feelings of control and value when completing the assignment. These findings largely reflect much of the research on CVT and achievement emotions albeit using different methodology (i.e., measuring emotions during learning and appraisals during later independent work). For example, Goetz and colleagues (2010) used experience-sampling methods (six measurements per day for one week) and found that control and value appraisals positively predicted feelings of enjoyment, pride, and contentment (all
positively-valenced emotions). Jarrell, Harley, and Lajoie (2016) measured medical students’ appraisals and emotions experienced during a computer game (designed to practice diagnosing patients based on symptomology) just after completion of said game; results showed that participants who experienced negative emotions (measured by clustering reports of anxiety, hopelessness, shame, and anger) during the game felt less in control and placed less value into doing the task than those who experienced positive emotions (measured by clustering reports of enjoyment and hope). Shao and colleagues (2020) more specifically found that low control appraisals were directly related to increased feelings of anxiety, hopelessness, shame, and anger and low value appraisals were directly related to increased feelings of hopelessness and shame measured in a university foreign language course across a semester.

Participants who reported experiencing more TUT when watching the online lecture also tended to report lower control and value appraisals when completing the post-lecture assignment. This suggests that participants’ own awareness of their wandering thoughts during learning had implications for how they perceived the control they had and the value they placed into completing a later assignment. Interestingly, results did not show similar patterns for experiences of FMT and PCs. Participants’ awareness of how freely-moving and personally connective their thoughts were did not seem to be related to how they appraised control and value in completing the assignment. These results may reflect the current state of the literature investigating the role of emotions and discrete signatures of thoughts.

For example, there is a small but growing body of literature teasing apart the relationship between experiences of TUT and increased negative emotions, especially boredom (Eastwood, Frischen, Fenske, & Smilek, 2012; Mills, Porter, Andrews-Hanna, Christoff, & Colby, 2021; Raffaelli, Mills, & Christoff, 2017; Smallwood, Fitzgerald, Miles, & Phillips, 2009; Stawarczyk,
Majerus, & D’Argembeau, 2013). Analyses from the current study show that reports of TUT during learning are positively correlated with anger, frustration, and boredom while being negatively correlated with enjoyment, supporting this past work. There is only one study to date that has examined FMT and emotion which found that experiences of FMT predicted concurrent and subsequent positive affect (Mills, Porter, Andrews-Hanna, Christoff, & Colby, 2021). While there is no direct research that has investigated the relationship between PCs and emotion, there is related evidence that divergent thinking (i.e., expanding your capacity of thought to include many different possibilities), which is likely involved in the generation of a PC, gave rise to a positive mood state (Akbari Chermahini & Hommel, 2012). Although, there is also mixed results suggesting this may not be the case (see Clapham, 2001). The current study found that only experiences of boredom during learning were positively correlated with FMT and experiences of enjoyment and anger during learning were positively correlated with PCs. Therefore, there may not be enough evidence to conclude that FMT and PCs have similar relationships with emotions as TUT more clearly appears to have. It could thus be argued that perhaps the lack of consistent, substantial relationships between emotions and FMT and PCs might preclude these two dimensions of students’ thoughts from being directly related to control and value appraisals during post-learning independent work. The strong concurrent negative emotions along with experiences of TUT may have a more robust impact on how students appraise how well they felt they learned or how well they perceive they are doing on an assignment in the moment. Overall, it may be the case that emotions primarily drive the control and value appraisals students make rather than the particular content or dynamics of their thoughts during online learning.

Furthermore, the current study’s exploration of activity emotions (occurring during a learning task) provided an opportunity to test Pekrun’s (2006) ideas regarding how appraisals
generated during learning impact the concurrent experience of activity-based emotions (see Table 3). Using a probe-caught method (Weinstein, 2017) to assess appraisals and emotions allowed for a closer examination of the CVT. Pekrun’s (2006) hypotheses were largely supported in that high value and control appraisals were related to feelings of enjoyment, low control appraisals were related to feelings of frustration, and low value and control appraisals were related to feelings of boredom. Participants tended to report enjoying what they were learning when they also felt in control of their learning and valued the information. Conversely, participants tended to report feeling frustrated or bored during learning when they also did not feel in control of their learning and placed low value in learning the information. Notably, while the patterns of appraisals predictive of frustration and boredom are similar, the correlation between value and boredom is much stronger than between value and frustration; this might imply that low value appraisals are a more potent contributor of boredom. The current study did not find any relationship between appraisals and feelings of anger in addition to not finding a relationship between high value (positive or negative) appraisals and feelings of frustration. See Table 15.

Lastly, results showed negative correlations between performance on multiple-choice comprehension questions and the short answer essays and TUT, FMT, anger, and boredom. TUT and FMT were not significantly related to academic performance in Study One (see General Discussion for more on why this may be). However, control and value appraisals made throughout learning were positively related to academic performance, suggesting that participants who felt more in control over their learning and valued the information being learned were more successful at retaining information from an online lecture. Ultimately, these results support the role of appraisals generated both during learning and during independent work in
giving rise to students’ learning experience—the thoughts they have, the emotions they feel, and their overall performance. However, there are differences in these patterns between in-person and online learning (see Appendix 2 for direct comparisons).

<table>
<thead>
<tr>
<th>Appraisals</th>
<th>Emotion</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive (Success)</td>
<td>Enjoyment</td>
<td>Supported; high value and high control appraisals related to feelings of enjoyment</td>
</tr>
<tr>
<td>Negative (Failure)</td>
<td>Anger</td>
<td>Unsupported; no relationships between value and control appraisals and feelings of anger</td>
</tr>
<tr>
<td>Positive or Negative</td>
<td>Frustration</td>
<td>Half supported; low control appraisals related to feelings of frustration</td>
</tr>
<tr>
<td>Low/None</td>
<td>Boredom</td>
<td>Supported; low value and low control appraisals related to feelings of boredom</td>
</tr>
</tbody>
</table>

Note. Due to the limitations of the current set of experiments, it could be that the lack of a true simulation of learning in Study Two and/or using an online medium is driving these unsupported or half supported findings.

**General Discussion**

The current pair of studies aimed to establish relationships between cognitive appraisals related to academic achievement and experiences students commonly have throughout learning. Study One was completed in a real-life classroom, and revealed that students’ appraisals of the control they have over their learning and the value they place into their learning directly influences the amount of task-unrelated thought, freely-moving thought, and personally connective thought they experienced in the classroom. Results generally show that different
patterns of appraisals give rise to different phenomenological experiences. Study Two attempted to experimentally induce patterns of appraisals to test whether students’ achievement appraisals causally impacted the thoughts they ended up having during online learning. A secondary goal of Study Two was to see how achievement appraisals made during learning impact appraisals, phenomenological experiences, achievement emotions, and learning outcomes from independent work after learning. Overall, Study Two found there was no such effect of instructor speech on inducing certain patterns of appraisals, but results did show how appraisals and phenomenological experiences during online learning are related to performance on a post-lecture assignment. Together, these two studies have provided some new theoretical contributions by (a) considering a more comprehensive understanding of what students go through during learning (e.g., dimensions of thought) and (b) capturing momentary changes in students’ appraisals and phenomenological experiences during learning and while completing independent work over time (on a smaller scale than most past research).

Most related work has focused on achievement emotions and how emotions related to academic performance manifest as a function of the cognitive appraisals that students generate regarding their learning progress (see Pekrun, 2022). However, there is also a growing body of research working to understand the relationship between thinking and emotion (e.g., Mills, Porter, Andrews-Hanna, Christoff, & Colby, 2021). Individuals’ goals, beliefs, attention, knowledge, thoughts, and more converge with our experience of emotion to create our phenomenological experiences at any given moment (Stein & Trabasso, 1992). All these experiences can continuously affect students’ information retention and learning outcomes. The rationale behind the current set of experiments borrowed from the idea that the appraisals that give rise to achievement emotions may also be shaping the content and dynamics of students’
thoughts. Results from Study One and Study Two show exactly that (albeit in different ways across in-person and online learning environments).

Results from Study One found that (a) low control and value appraisals predicted increased reports of TUT, (b) low control appraisals predicted increased reports of FMT, (c) high value appraisals predicted increased reports of PCs during lecture learning, and (d) high value appraisals and increased reports of PCs predicted better academic performance on learning assessments. Out of the repeated measurements between both studies, results from Study Two only replicated the effects of low and high value on TUT and PCs, respectively, and the effect of high value appraisals on better academic performance. See Table 16 for a list of results unique to Study One, overlapping results from both studies, and results unique to Study Two. The low control appraisals that predicted more reports of FMT throughout lecture learning held in a classroom did not hold true for lecture learning online; because classroom learning appears to constrain students thoughts more so than online learning (see Appendix 2), it may be the case that students attempted to think freely and broadly to find connections (whether personal or not) when they were aware of their low control appraisals to try to regain control over their learning. In this particular explanation for results found during in-person learning, students may have eventually begun thinking of more task-unrelated information (TUTs) if they were unable to regain feelings of control; hence why Study One finds a relationship between low control appraisals and increased reports of TUT and Study Two does not. Results from Study One also show that academic performance assessed after each lecture was better when students generated more PCs during learning, which did not replicate in Study Two. However, learning in a classroom appeared to result in students making more PCs than when they were learning online.
THOUGHTFUL LEARNING

(see Appendix 2). Classroom environments may thus facilitate the generation of PCs so much so that those increased rates of connections result in better academic performance.

<table>
<thead>
<tr>
<th>Study One (Classroom)</th>
<th>Both Studies</th>
<th>Study Two (Online)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Control → More TUTs</td>
<td>Low Value → More TUTs</td>
<td>High Control → Better Academic Performance</td>
</tr>
<tr>
<td>Low Control → More FMTs</td>
<td>High Value → More PCs</td>
<td>More TUTs → Worse Academic Performance</td>
</tr>
<tr>
<td>More PCs → Better Academic Performance</td>
<td>High Value → Better Academic Performance</td>
<td>More FMTs → Worse Academic Performance</td>
</tr>
</tbody>
</table>

*Note. 1) These predictions are non-causal. 2) Control and value measures referenced here were measured during lecture learning (in classroom and online).*

Additionally, results from Study Two show that (a) high control appraisals correlated with better academic performance on learning assessments and (b) increased reports of TUTs and FMTs correlated with worse academic performance on learning assessments. Control appraisals made while learning in a classroom did not significantly predict academic performance, however the capacity of control students can feel between in-person and online learning has been shown to differ (Biwer et al., 2021; Kee, 2021). Thus, given past research has shown that students tend to feel less in control of their learning when in online environments (see Kee, 2021), high degrees of control might have stronger or more prevalent influence over academic performance when learning online in comparison to being in the classroom. Note that the current studies did not find a significant difference in ratings of control appraisals between in-person and online learning (see Appendix 2), but that does not negate the idea that feelings of high control when learning online may uniquely encourage deeper retention of the material.
because of the difficulty of virtual learning. Conversely, TUTs and FMTs may be particularly
damaging to academic performance in online environments in comparison to in-person learning.
Sufficient evidence has shown that attention struggles and wandering thoughts tend to decrease
learning outcomes (see Wong, Smith, McGrath, Flynn, & Mills, 2022). Students reported
experiencing more FMTs when learning online compared to in the classroom, suggesting that
one’s thoughts during virtual learning may be more susceptible to free-flowing and potentially
distracting ideas leading to worse academic performance. While there was no difference in rates
of reported TUTs between online and in-person learning environments, data collection for Study
One occurred in the classroom over the course of four lecture days all describing very different
topics in an introductory psychology course. Results even show that reports of TUT differed
across each of those four lectures (i.e., students experienced more task-unrelated thoughts when
learning about Freud’s psychoanalytic theory in lecture one compared to contemporary [and
likely more relatable] theories of personality in lecture two; see Appendix 2). This could possibly
hide a true effect of TUT rates between the two learning mediums due to having to collapse all
reports of TUT across four very different in-person lectures into an average to compare to the
average number of TUTs reported while learning online.

Overall, some results failed to fully replicate from Study One to Study Two. This may
also be because the lectures for Study One were naturalistic and the lectures created for Study
Two might not have adequately simulated a real-world learning scenario and instead felt
artificial for participants. The difference in a naturalistic versus experimental setting may very
well account for the varying results found between the two studies reported here. However, the
results from both studies do still emphasize the importance of how appraisals generated at any
given moment can subsequently affect the thoughts students end up having and their academic
future work should clarify to what extent experimental manipulations change students’ learning experiences compared to naturalistic classroom settings.

The current set of experiments also zoomed in on how we can measure appraisals over time on different scales. Both Study One and Two probed participants on their appraisals, thoughts, and affect at three or four time points throughout a lecture, however Study One measured students’ experiences across four different in-person lectures and Study Two measured students’ experiences across one online lecture and assignment. Study Two also added probes to assess the four emotion states Pekrun (2006) hypothesized would be experienced during learning (i.e., activity emotions). In Study One, pre-lecture appraisals predicted participants’ thoughts differently than appraisals generated throughout a lecture. Participants’ own awareness of the content and dynamics of their thoughts during lecture also predicted their perceptions of their learning in post-lecture appraisals. Similarly, in Study Two, appraisals generated throughout a lecture revealed different relationships with appraisals generated before, during, and after completion of independent work. In general, these results stress the importance of using precise measurement of the momentary changes in students’ phenomenological experiences over smaller time scales. In this way, research can (a) more comprehensively understand what students are going through while learning and (b) structure pedagogical practices to adhere to their changing perceptions of their abilities.

Limitations

Study Two was designed to try to experimentally induce certain patterns of appraisals and corresponding thought dynamics and emotions based on calculated statements made by an instructor. Findings did not result in the expected patterns; there were no such effects of instructor messages on participants’ appraisals, thoughts, and emotions. It could be the case that
cognitive appraisals are very personal to an individual in that external influence (e.g., an instructor urging students to pay attention because the next piece of information will be on an upcoming exam) does very little to change one’s perception of an event; the personal cognitive, emotional, and interoceptive information guiding our evaluations of any given experience may override potential circumstantial pressures. Conversely, the manipulation might not have been strong enough due to our efforts to control for confounding variables (e.g., differences in emphasis, tone, and speed for the delivery of the instructor messages). The online format in which the lecture was watched also might have unintentionally destressed the meaning behind the instructor messages as well, such that participants may have placed less importance on what the instructor was saying while learning online than if they were learning in a classroom.

Additionally, we found some unexpected counterbalance effects in Study Two for counterbalance B. Outliers were ruled out as a possible reason for these effects and there are no other plausible reasons as to why counterbalance B decreased boredom and TUT in comparison to the other counterbalanced conditions given the use of the Latin Square Design. Additionally, participants’ reported interest in the topic learned and prior knowledge of the information from the lecture had no effects on the difference seen for counterbalance B. Despite randomly assigning participants to conditions prior to them beginning the experiment, it could be the case that participants in counterbalance B just happened to feel less bored and experience less TUT. This is therefore a limitation of Study Two.

**Future Directions**

Much of the research studying academic outcomes has focused on implementing programs or interventions aimed to change various learning circumstances, such teaching techniques, classroom environments, learning platforms, and *even* students’ emotions, to
ultimately increase students’ retention. For example, some past work has shown that specifically reducing anxiety and boredom in the classroom can improve learning outcomes (Feuchter & Preckel, 2021; La Marca & Longo, 2017; Macklem, 2015). This work suggests that if students can recognize these negative emotions and intentionally lessen physiological arousal (such as that experienced when feeling anxious), then perhaps they could adjust their appraisals and thought patterns to increase learning. A few studies to date have attempted just this, however there is much still to understand when trying to change students’ phenomenological experiences to improve learning.

For instance, Ruthig, Perry, Hall, and Hladkyj (2004) investigated how rates of dispositional optimism and attributional training aimed at focusing students on the effort they can exert rather than their natural abilities can change their test anxiety among other academic factors. They found that students who were highly optimistic had the lowest GPAs, highest course withdrawal rate, and high rates of test anxiety; however, these highly optimistic students also benefited the most from the attribution retraining in all ways. This study shows that attribution retraining was effective—especially for at-risk students (i.e., optimistic students). Cavanagh and colleagues (2021) implemented a program to test whether students could strategically adjust their appraisals and mindfulness to regulate emotion and improve learning. These authors similarly found that providing students with appraisal strategies helped to improve learning outcomes by positively resetting students’ thoughts and emotions before diving into learning. Overall, both these studies show that having students take a second to focus before class on thinking about and implementing strategies during learning (e.g., focusing on effort rather than ability or being mindful) is enough to improve learning outcomes.
To build upon this initial work, researchers need to find ways to (a) continually remind students to positively reframe their learning appraisals and (b) personalize those reminders to better accommodate each students’ learning experience. Ruthig, Perry, Hall, & Hladkyj (2004) used a one-time attribution retraining treatment but did not consistently respond to learner’s needs in the moment. Therefore, the continuous nature of reminding students in the moment of changing attributions/appraisals may help aid student learning further. Cavanagh and colleagues (2021) also found no effects of short-term learning, which leaves more room for exploration as to how adjusting participants’ thoughts and appraisals in the moment might help. Tailoring a training program to a student’s individual phenomenological experiences during learning would likely be far more effective in improving learning outcomes in both the short- and long-term. Future work building off this dissertation and past research should thus aim to build a computational model to detect and respond to when students’ thoughts become maladaptive (e.g., TUTs or overly constrained thoughts) by attempting to change the appraisals students have, ultimately impacting their academic success and retrospective attributions. If we can measure students’ thoughts in the moment (e.g., analyzing their ongoing thoughts about their individual capability, perceptions of task demands, etc.), then technology can better aid students in focusing on their learning.

**Conclusion**

The set of current studies examined how appraisals influence the thoughts and phenomenological experiences students have during learning—going a step beyond prior research exclusively studying the effects of appraisals on achievement emotions. Broadly, results found that the appraisals students make regarding how in control over their learning they feel and the value they place into learning during a lecture have implications for the types of thought they
experience. The learning environment (in the classroom or online) additionally has differential effects on how appraisals give rise to students’ phenomenological experiences. The current studies did not successfully manipulate appraisals using instructor speech but revealed interesting relationships between how students’ appraisals made during learning impact appraisals made during completion of independent work. All in all, these studies add insight to our current understanding of appraisals, emotion, and student learning by expanding the CVT with multiple dimensions of thought (i.e., TUT, FMT, and PC) and a smaller temporal scale of measurement (i.e., throughout a lecture and completion of an assignment rather than over the course of a semester or academic year).
References


Perez, T., Cromley, J., & Kaplan, A. (2013). The role of identity development, values, and costrs, in college STEM retention. *Journal of Educational Psychology, 3*, 4-11.


APPENDIX ONE

Post-Lecture Assignment for Study Two

Below are four questions you are to answer based on what you learned from the lecture video.

Please write brief responses (3-5 sentences) to answer each question.

1. Describe the two systems underlying the dual-process theory of consciousness. What is a practical example of each in action? [Answer: automaticity/system one and control/system two; making a snap judgement vs. solving a complex math problem]

2. Describe the relationship between concepts and categories. How do they each create the content of our thoughts? [Answer: categories (collection of similar instances) give rise to or govern concepts (abstract grouping of knowledge from different categories)]

3. Describe automatic and deliberate constraints on thought in the context of the below scenario: How might both types of constraints differ with respect to convergent and divergent thinking on creativity tasks? [Answer: sensory or affective salience vs. cognitive control; convergent creativity requires more deliberate constraints than divergent creativity]

4. In class you learned about the functions of dreaming. Describe how is dreaming is considered “overnight therapy.” [Answer: we sleep to remember valuable information, but we dream to forget or dissolve the painful emotion charge of memories; include some evidence talked about from lecture]

Responses for each question will be scored based on the below rubric:

<table>
<thead>
<tr>
<th>Score</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Participant very clearly demonstrated mastery of the psychological concepts they wrote about; Participant also answered the full extent of the prompt without leaving any of the important points written above in the bold brackets</td>
</tr>
<tr>
<td></td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>-------------</td>
</tr>
<tr>
<td>B</td>
<td>Participant demonstrated good memory for the psychological concepts they learned about and made little errors; Participant also answered the full extent of the prompt or may have missed one important point written above in the bold brackets</td>
</tr>
<tr>
<td>C</td>
<td>Participant may have misunderstood some of psychological concepts they wrote about; Participant may have missed two important points written above in the bold brackets</td>
</tr>
<tr>
<td>D</td>
<td>Participant very much misunderstood the psychological concepts they wrote about; Participant did not fully answer the question or may have missed three important points written above in the bold brackets</td>
</tr>
<tr>
<td>F</td>
<td>Participant failed to answer the question correctly</td>
</tr>
</tbody>
</table>
APPENDIX TWO

Supplemental Analyses

Additional logistic mixed-effects regression models were conducted to test how reports of students’ experiences changed (a) from lecture to lecture [in Study One], (b) from probe to probe [in Study Two], and (c) across classroom [Study One] and online [Study Two] learning environments. All models regressed TUT, PC, FMT, control appraisals, value appraisals, and affect measured during learning onto either lecture, probe, or learning medium and included a random intercept for each participant to control for within-subject variability across their multiple responses. See Table 17 for descriptive statistics.

Lecture-to-Lecture

Lectures appeared to have a significant effect on reports of task-unrelated thought \( (\chi^2(3) = 10.53, p = .015) \), personal connections \( (\chi^2(3) = 57.13, p < .001) \), control appraisals \( (\chi^2(3) = 9.44, p = .024) \), value appraisals \( (\chi^2(3) = 54.33, p < .001) \), and affect, \( \chi^2(3) = 9.09, p = .028 \). Specifically, pairwise comparisons revealed that TUT rates were higher in lecture one \( (EMM = 5.43, SE = .242) \) than lecture two, \( EMM = 4.76, SE = .245, t(571) = 3.21, p = .008 \). Lecture one discussed classic theories of personality (e.g., Freud’s psychoanalytic theory) which may have prompted more off-topic thoughts compared to lecture two that discussed contemporary theories of personality (e.g., the Big Five) which may be more relevant and interesting to students. The number of personal connections that students made changed across the four lectures as well, \( \chi^2(3) = 57.13, p < .001 \). Reports of personal connections during lecture one were reliably lower \( (EMM = 3.71, SE = .242) \) than the other three lectures (all \( ps < .001 \)). Additionally, reports of personal connections during lecture two \( (EMM = 4.53, SE = .246) \) were reliably lower than lectures three \( (EMM = 5.27, SE = .246, t(585) = -3.03, p = .014) \) and four, \( EMM = 5.32, SE = \)
There were no differences in the amount of personal connections made during lectures three and four, \(t(579) = 0.19, p = .998\). Participants may have not found lecture one on Freudian psychology to be relatable, which might not have sparked many personal connections. In contrast, lectures three and four discussed psychopathology (mood disorders, anxiety disorders, and psychotic disorders) which may have been particularly relatable for participants given the rise in mental health struggles amongst college students (Xiao, Carney, Youn, Janis, Castonguay, Hayes, & Locke, 2017). Participants’ reports of freely-moving thought did not change from lecture to lecture, \(\chi^2(3) = 3.32, p = .345\). The degree of participants’ control appraisals varied across the four lectures (\(\chi^2(3) = 9.44, p = .024\)) in that control appraisals were higher while listening to lecture three (\(EMM = 3.90, SE = .123\)) than lecture four, \(EMM = 3.64, SE = .128, t(544) = 2.93, p = .019\). The content of lecture three (e.g., symptoms associated with major depressive disorder and bipolar disorder) may have been more accessible and straightforward than the content of lecture four (e.g., symptoms associated with panic disorder and schizophrenia), which resulted in students feeling as if they are more in control of their learning. The degree of participants’ value appraisals also varied across the four lectures, \(\chi^2(3) = 54.33, p < .001\). Value appraisals changed across the four lectures in a similar pattern as participants’ personal connections. Participants’ reported perceived value in mastering the information being learned was lowest during lecture one (\(EMM = 3.27, SE = .105\), all \(ps < .05\)) in comparison to the other lectures. Value appraisals reported during lecture two (\(EMM = 3.52, SE = .106\)) was lower than during lectures three (\(EMM = 3.83, SE = .105, t(558) = -3.45, p = .003\)) and four, \(EMM = 3.86, SE = .112, t(552) = -3.47, p = .003\). There was no difference in value appraisals between lecture four and five, \(t(552) = -0.229, p = .996\). Students likely found the lectures on psychopathology (lectures three and four) to contain knowledge that is more valuable
to know in their futures than the lectures on personality theories (lectures one and two); however, students also appeared to have judged the knowledge they learned on contemporary theories of personality to be more valuable to know than classic theories of personality. Participants’ general affect also changed across the four lectures, $\chi^2(3) = 9.09, p = .028$. Affect was reported as being significantly more negative during lecture three ($EMM = 5.02, SE = .187$) in comparison to lecture one, $EMM = 5.48, SE = .184, t(526) = 2.82, p = .026$. Discussing depressive and bipolar disorders during lecture three might have inadvertently made students feel more negative in comparison to discussing Freud’s psychoanalytic theory during lecture one. These results overall suggest there is a strong effect of the content of a lecture on how students experience various types of thoughts, appraise the information they are learning, and feel positively or negatively during learning. See Table 17 and Figure 5 for more information.

*Figure 5. Changes in Students’ Average Reports across Four Lectures (from Study One)*
Probe-to-Probe

Timing of the probes across a lecture appeared to have an effect on participants’ reports of TUT, $\chi^2(3) = 55.68, p < .001$. Specifically, task-unrelated thought reported at probe one ($EMM = 4.88, SE = .132$) was significantly lower than at probes two ($EMM = 5.59, SE = .132$, $t(853) = -5.29, p < .001$), three ($EMM = 5.65, SE = .132$, $t(853) = -5.76, p < .001$), and four, $EMM = 5.79, SE = .132$, $t(853) = -6.82, p < .001$. There were no differences in reported TUT between probes two, three and four (all $ps > .40$). This is consistent with much of the literature, in that TUT typically increases as attention wanes over time during a task (e.g., Smallwood, Obonsawin, & Reid, 2002). Reports of personal connections also changed across the four probes, $\chi^2(3) = 91.26, p < .001$. There were no reliable differences in rates of PCs between probes one ($EMM = 4.56, SE = .129$) and two ($EMM = 4.81, SE = .129$, $t(853) = -1.75, p = .298$) as well as between probes three ($EMM = 3.81, SE = .129$) and four ($EMM = 3.71, SE = .129$, $t(853) = 0.74, p = .881$). Personal connections at probes one and two were reported significantly more than at probes three and four (all other $ps > .001$), suggesting that students seem to generate more personally relevant connections between lecture content earlier during learning as opposed to later during learning. Experiences of freely-moving thought did not reliably differ from probe to probe throughout a lecture, $\chi^2(3) = 2.93, p = .403$. How in control of their learning participants’ made judgments about did vary across the four probes, $\chi^2(3) = 65.21, p < .001$. Much like how reports of personal connections changed, control was appraised as much higher at probes one ($EMM = 3.88, SE = .057$) and two ($EMM = 3.78, SE = .057$) than both three ($EMM = 3.58, SE = .057$) and four, $EMM = 3.56, SE = .057$, all $ps > .001$). There were no differences in control appraisals between probes one and two ($t(854) = 2.18, p = .130$) as well as probes three and four, $t(854) = 0.53, p = .951$. Similarly, the value participants perceived in learning the lecture
material changed over time, \( \chi^2(3) = 98.29, p < .001 \); value was judged as higher at probes one 
\((EMM = 3.70, SE = .059)\) and two \((EMM = 3.60, SE = .059)\) than probes three \((EMM = 3.35, SE = .059)\) and four, \(EMM = 3.27, SE = .059\), all \(ps > .001\). There were also no differences in value appraisals between probes one and two \((t(854) = 2.07, p = .165)\) and between probes three and four, \(t(853) = 1.56, p = .400\). How enjoyable participants felt throughout the lecture also reliably changed, \( \chi^2(3) = 109.40, p < .001 \). In particular, enjoyment was reported as higher at probes one 
\((EMM = 4.00, SE = .116)\) and two \((EMM = 3.85, SE = .116)\) in comparison to probes three 
\((EMM = 3.26, SE = .116)\) and four, \(EMM = 3.18, SE = .116\), all \(ps < .001\). Enjoyment did not 
differ between probes one and two \((t(854) = 1.55, p = .409)\) as well as between probes three and 
four, \(t(854) = 0.80, p = .856\). Experiences of anger also changed throughout the lecture, \( \chi^2(3) = 10.04, p = .018 \). Feelings of anger did not change between probes one \((EMM = 1.55, SE = .071)\), 
two \((EMM = 1.47, SE = .071)\), and three, \(EMM = 1.46, SE = .071\). However, anger significantly 
increased from probe three to probe four, \(EMM = 1.62, SE = .071, t(853) = -2.81, p = .026\). 
Participants may have reported experiencing more anger at probe four because it was at the end 
of the lecture, and they were ready to move on what was next in their day. Interestingly, feelings 
of frustration did not differ from probe to probe \((\chi^2(3) = 5.75, p = .124)\), implying that 
participants’ frustration might not change as long as their learning is progressing at a steady rate. 
Reports of boredom varied significantly throughout the lecture, \( \chi^2(3) = 12.0, p = .007 \). The only 
statistically significant difference in feelings of boredom was between probes two \((EMM = 5.12, 
SE = .142)\) and four \((EMM = 5.54, SE = .142, t(854) = -3.26, p = .006)\), such that boredom 
increased from earlier in the lecture compared to later in the lecture; this pattern may suggest that 
students feel the least bored once an instructor starts to dive into slightly deeper material (about a 
quarter of the way into a lecture) and most bored toward the very end of the lecture before they
are about to leave the class for the day. General affect also changed significantly from probe to probe, $\chi^2(3) = 46.86, p < .001$. Affect was reported as more positive during probes one ($EMM = 5.37, SE = .072$) and two ($EMM = 5.28, SE = .072$) and then more negative during probes three ($EMM = 5.08, SE = .072$) and four, $EMM = 4.96, SE = .072$, all $ps > .020$. There were no differences in participants’ affective state between probes one and two ($t(854) = 1.41, p = .493$) as well as probes three and four, $t(854) = 1.78, p = .286$. Overall, these results suggest that the halfway mark in a 40-minute lecture is when students begin feeling a loss of control over their capabilities to master the information and de-value what they are learning in the process; this may be related to a decrease in personally connecting with the information they are learning and lessening enjoyment [and more negative affect] throughout a lecture. Future work should tease apart the relation between these phenomena to better understand how one experience may lead to another or if there is a domino effect of sorts occurring. Additionally, experiences of TUT change (increase) rather early throughout a lecture (between probes one and two) and feelings of anger change (increase) rather later throughout a lecture (between probes three and four). The reasons as to why some phenomenological experiences change in the beginning, middle, or end of a learning session should be further investigated. See Table 17 and Figure 6 for more information.
Classroom v. Online

The mode in which learning occurred (in the classroom or online) appeared to impact the degree to which participants’ thoughts freely moved during learning ($\chi^2(1) = 14.09, p < .001$) as well as the rates participants reported experiencing personal connections to the learning material ($\chi^2(1) = 4.29, p = .038$), but not TUT ($\chi^2(1) = 2.46, p = .117$), control appraisals ($\chi^2(1) = 0.31, p$
Results show that participants reported their thoughts as being more freely-moving when learning online ($EMM = 5.31, SE = .099$) in comparison to being in the classroom, $EMM = 4.51, SE = .189, t(309) = 3.75, p < .001$. Classrooms may therefore provide more structure in terms of constraining students’ thoughts. Additionally, participants reported experiencing more personal connections with the content they were learning when in the classroom ($EMM = 4.65, SE = .180$) rather than online, $EMM = 4.22, SE = .099, t(279) = -2.07, p = .039$. An online environment may allow students to personally disengage from what they are learning more so than a classroom due to the lack of face-to-face contact with and instructor and other students. There seems to be no difference in how appraisals are judged, TUTs wander, and general affect is experienced regardless of where a learner is listening to a lecture; this implies that how information is learned has more specific effects on students’ phenomenological experiences than previously understood. See Table 17 for more information.
Table 17. Descriptive Statistics Across Various Conditions [M(SD)]

<table>
<thead>
<tr>
<th>Online Measure</th>
<th>Study One</th>
<th>Study Two</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lecture 1</td>
<td>Lecture 2</td>
</tr>
<tr>
<td>Control</td>
<td>3.76(1.10)</td>
<td>3.72(1.15)</td>
</tr>
<tr>
<td>Value</td>
<td>3.28(1.16)</td>
<td>3.58(1.01)</td>
</tr>
<tr>
<td>Task-Unrelated Thought</td>
<td>5.49(2.58)</td>
<td>4.71(2.34)</td>
</tr>
<tr>
<td>Freely-Moving Thought</td>
<td>4.52(2.48)</td>
<td>4.41(2.18)</td>
</tr>
<tr>
<td>Personal Connections</td>
<td>3.74(2.47)</td>
<td>4.43(2.41)</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Anger</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Frustration</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Boredom</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Affect</td>
<td>5.45(1.72)</td>
<td>5.14(1.73)</td>
</tr>
</tbody>
</table>