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EXAMINING THE ROLE OF A METACOGNITIVE PROMPTING INTERVENTION TO SUPPORT STUDENTS' SELF-REGULATED AND MULTIPLE-TEXT LEARNING

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ABSTRACT

The purpose of this study was to examine the effects of a metacognitive prompting intervention grounded in Winne and Hadwin's (1998) model of self-regulated learning (SRL). This study employed a pretest-posttest design with a metacognitive prompting with integration reminder (MP+I) treatment condition, a metacognitive prompting (MP) treatment condition, and a control condition. Participants included undergraduate students who were randomly assigned to conditions. The key independent variable in this study was the manipulation of intervention prompts across conditions. The MP+I and MP conditions received prompts throughout their learning task, while the control condition did not receive any prompts. In the learning task, participants engaged with two refutation texts addressing the learning styles myth and were prompted to compose an essay in response to a researcher-generated prompt. Multiple-text learning and SRL outcomes were of interest in this study. Dependent measures included a researcher-generated knowledge assessment, the shortened Metacognitive Awareness Inventory (Harrison & Vallin, 2018; Schraw & Dennison, 1994), monitoring bias and monitoring absolute accuracy indices calculated from confidence judgments, an essay-based writing prompt completed during the learning task, and an adapted version of the Multiple-Text Strategy Inventory (Bråten & Strømsø, 2011). Across the outcome measures, results indicated little support for the metacognitive prompting treatment conditions. Findings suggest that the present intervention was not effective. However, across conditions, results showed that all students learned and demonstrated gains in metacognitive awareness. Limitations and directions for future research are discussed.

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Chapter 1

Introduction

People's daily lives require engaging with multiple texts. Although certainly prevalent in less formal contexts (e.g., reading multiple online documents about a health diagnosis), learning from multiple texts occurs across grades and domains in formal educational contexts. Multiple-text reading is qualitatively different from reading from a single text (Perfetti et al., 1999), as it requires unique processes including integration and source evaluation (e.g., Rouet & Britt, 2011; List & Alexander, 2019). The ability to engage these processes is a highly valued goal in educational contexts (e.g., NAEP, Common Core State Standards), likely because multiple-text learning processes require students to demonstrate deeper learning outcomes. Multiple-text learning and its related tasks are complex, however, as they require prior knowledge about content and effective strategies, often take prolonged periods of time, and include many sub-steps (e.g., Barzilai et al., 2018; Rouet & Britt, 2011). Learners are also oftentimes expected to complete such tasks independently and are given an extraordinary amount of control over and responsibility for their learning. For example, undergraduate students commonly write argumentative essays and research papers in their program coursework. A student studying education may decide to write a final argumentative essay for a course asserting that restorative practices are effective alternatives to traditional behavior policies like detention and suspension.

Despite its prevalence, research shows that learners often struggle with multiple-text learning processes. Students do not tend to automatically implement the processes required for successful, meaningful learning, such as integrating content across texts (e.g., Barzilai et al., 2018) and evaluating the credibility and quality of the texts themselves (e.g., Brante & Strømsø, 2018). In addition, researchers have demonstrated that individual differences significantly impact students' learning from multiple texts (Anmarkrud et al., 2021). As a result, researchers have not only explored interventions to support integration and source evaluation processes, but also studied how to structure multiple-text learning tasks effectively to promote learning.

The Current Approach

Within the field of learning from multiple texts, terminology used is often inconsistent. For example, "texts," "documents," "sources," "information sources," and "resources," are commonly used interchangeably to refer to information artifacts. In the current study, I adopted a definition of "texts" that reflects those documents that are primarily text-based and use "texts" and "documents" interchangeably. I reserved "sources," "information sources," and "resources" for those artifacts that represent information in alterative formats, such as videos.

The field of multiple-text learning emerged from several foundational strands of research. For example, in his seminal study, Wineburg (1991) described how high school students and expert historians differed in their evaluation of primary and secondary historical documents. Participants engaged with eight text-based and three pictorial-based documents and were instructed to think aloud while trying to understand what happened at the Battle of Lexington. Wineburg's major finding was that the experts engaged in sourcing during study:

> "Historians seemed to view texts not as vehicles but as people, not as bits of information to be gathered but as social exchanges to be understood. Viewed in this light, the sourcing heuristic is not really a rule of thumb or problem-solving strategy as much as it is the manifestation of a belief system in which texts are defined by their authors" (Wineburg, 1991, pp. 83-84).

Another foundational strand of research includes Perfetti and colleagues' (1999) differentiation of multiple-text reading from single-text reading through the documents' model, which is discussed in greater detail below. Since then, researchers have demonstrated that reading from multiple texts is, in fact, distinct in several important ways.

First, multiple-text and single-text reading result in different representations. While single-text reading produces intra-textual representations, multiple-text reading produces both inter- and intra-textual representations (Perfetti et al., 1999). Although there are numerous models of comprehension (e.g., Kintsch's (1998) construction-integration model, Gernsbacher's (1997) structure-building model, Trabasso et al.'s (1989) causal network model), there are common assumptions across models. McNamara and Magliano (2009) reviewed seven prominent models of comprehension and identified eight shared assumptions. For example, most models assume that working memory is limited in capacity. Another shared dimension includes that of a connectionist architecture for representing the texts in memory. Comprehension includes activating one's prior knowledge, the information in the environment, and the meaning of the information in the environment. These information sources are activated by nodes (i.e., the information bits) and links (i.e., the relationships among the information bits).

However, Kintsch's (1988) construction-integration model is commonly cited and referenced in studies of multiple-text learning. In Kintsch's model, construction represents the processes through which the reader builds a text base from the input offered from the text. To do so, the reader builds the propositions relevant to the text's input, expands on propositions by using additional, relevant input, draws inferences, and generates connections among propositions and inferences. The reader's prior knowledge is critical, as it influences what the reader expects from the text, anticipates and infers while reading, and makes sense of from the text. Integration refers to how readers iteratively make connections with the text's content as reading occurs by refining what is deemed relevant from the construction process. The iterative, ongoing nature of construction and integration is what allows readers to engage in comprehending a text. Models of multiple-text learning will be discussed in greater detail below, but they generally do not focus on the local processing of each individual text at the propositional level. Instead, they may, for example, address how readers develop links among the documents themselves and form connections among the content in the documents (Perfetti et al., 1999). For instance, by tagging sources, or making explicit references to the documents in writing, learners are better positioned to demonstrate having an integrated representation of how the documents relate to one another.

Second, multiple-text and single-text reading are often situated in different task contexts. Although single-text reading is certainly influenced by the task (e.g., Mannes, 1988; McCrudden & Schraw, 2007), the nature of multiple-text tasks is often more complex. Much of people's daily lives demand integrating information from multiple texts, even outside of formal learning contexts. Whether it is searching for information about a health condition, making an informed decision about an important purchase, or exploring the scope of a new hobby, much of people's daily lives require or involve engagement with multiple documents. In more traditional educational contexts, multiple-text reading is often associated with making decisions, composing an argument, or demonstrating deeper knowledge about a given topic. None of these tasks would be adequately addressed with a single text.

Third, multiple-text and single-text reading vary significantly in their level of difficulty. Comprehension is a demanding and complex process that is required not only to develop meaning, but also to engage in higher-order cognitive processes (McNamara & Magliano, 2009). As a result, single-text reading is undoubtedly difficult. However, multiple-text reading requires the comprehension of each individual document and additional higher-level processes. In some cases, readers must not only make intra- and inter-textual connections within and among documents, but also evaluate the documents' credibility based upon source features (Brante & Strømsø, 2018). Arguably, the abundance of information available increases the complexity of learning from multiple texts. If the quality and credibility of information varies, this is an additional challenge learners must navigate (Bråten & Braasch, 2017). At the same time, to be successful, readers must also plan how they will approach the given task, monitor their progress, employ effective strategies, make adaptions when necessary, and develop a product that meets standards, whether they are task-based or personal.

Models of Multiple-Text Learning

The earliest influential multiple-text model is Perfetti and colleagues' (1999) documents model. The documents model was proposed to depict what a good representation of one's multiple-text learning might look like. It includes two interconnected models: a situation model and an intertext model. A reader's situation model refers to how they represent connections among events across multiple documents. A reader's intertext model refers to how they represent connections among the documents themselves. In both cases, a more sophisticated situation and intertext model is one that is more highly integrated and interconnected, which also results in a more advanced documents model.

Britt and colleagues (1999) expanded on the documents model by outlining additional related, yet distinct, models, including the *separate representation*, *mush,* and *tag-all* models. The models vary along dimensions of integration and source tagging. In the separate representation model, the reader does not integrate information across sources; instead, they form individual representations for each text, lacking connections among the texts. The reader may or may not tag sources in this model. In the mush model, however, the reader fully integrates information across sources but does not tag any of the documents. The lack of tagging reflects an assumption that author information was not stored in memory. Unlike the other models, the tag-all model is the most sophisticated; the reader not only tags but also integrates every document. This level of tagging and integration is extremely demanding given the level of processing required for the reader. Readers with high levels of expertise most commonly form the tag-all model.

Scholars have continued to develop models and frameworks that represent and advance extant research. This work resulted in several particularly influential models and frameworks that include the Multiple-Document Task-based Relevance Assessment and Content Extraction (MD-TRACE; Rouet & Britt, 2011) model, the REading as problem SOLVing (RESOLV; Rouet et al., 2017) model, the Cognitive Affective Engagement Model (CAEM; List & Alexander, 2017), and the Integrated Framework of Multiple-Text Use (IF-MT; List & Alexander, 2019).

In MD-TRACE, Rouet and Britt (2011) sought to examine the processes that unfold in functional multiple-text reading situations. Five processes are outlined in MD-TRACE: 1) generating a task model, 2) assessing information needs, 3) selecting, processing, and integrating document information, 4) creating a task product, and 5) evaluating the product's quality. Critical to these processes are the internal and external resources that readers utilize in multiple-document tasks. Internal resources like prior knowledge and self-regulation skills lie within the reader, while external resources like task parameters and the documents themselves are situated outside of the reader.

Like other models and frameworks, the RESOLV (Rouet et al., 2017) model assumes that reading is purposeful. Importantly, the model also examines how a reader's context model influences the decisions they make in text comprehension and use. In RESOLV, the a) physical and social context, b) reader representations and processes, and c) reader resources are critical components in reading. Regarding the physical and social context, elements including the request, requester, audience, support and obstacles, and self all impact the reader's representations and processes. In purposeful reading, RESOLV defines three major representations and processes: the reader's context model, the reader's task model, and reading processes and outcomes. Reader resources include prior context schemata, strategy knowledge, self-regulation skills, and reading component skills, vocabulary, and domain knowledge.

In an alternative approach to multiple-text learning, List and Alexander (2017) address a limitation of existing models: the lack of attention to warm approaches to processing of texts. In their CAEM, List and Alexander propose that students' multiple-text learning depends upon two dimensions: their affective engagement with the topic and their text evaluation behavioral habits. Four default stances emerge from these two dimensions: disengaged (i.e., low affective, low behavioral engagement), evaluative (i.e., low affective, high behavioral engagement), affectively engaged (i.e., high affective, low behavioral engagement), and critical analytic (i.e., high affective, high behavioral engagement).

Building on existing multiple-text models and their (2017) work, List and Alexander's (2019) IF-MT was developed to offer a renewed perspective on the critical components included in multiple-text processing, with particular attention to representing the range of extant research. In the IF-MT, multiple-text use occurs in three stages: preparation, execution, and production. In the preparation phase, individual difference factors, external task factors, and the learner's task perceptions shape the learner's default stance (List & Alexander, 2017) toward multiple source use. In the execution phase, learners implement metacognitive, cognitive, and behavioral strategies as they engage with multiple documents. In the production phase, the engagement with multiple texts results in cognitive and affective outcomes that are translated accordingly into an external task product.

Additional models and frameworks exist that capture more specialized multiple-text processes. For example, Stadtler and Bromme's (2014) Content-Source Integration (CSI) and Braasch and Bråten's (2017) Discrepancy-Induced Source Comprehension (D-ISC) models both target how learners process conflicting information. In the CSI, readers process conflicting information across sources in three phases, including detecting a conflict, regulating the conflict, and resolving the conflict. The reader's personal resources, such as cognitive and motivational processes, are assumed to underlie and influence processing across stages. In the D-ISC, Braasch and Bråten represent the cognitive processes that occur when readers engage with controversial information in single and multiple-text reading environments. In this model, when a reader encounters conflicting information, they may attempt to re-establish coherence through strategies like attending to source information.

Overall, the wide range of extant models and frameworks serve as the underlying foundation for studies conducted in the multiple-text field, including interventions. The models and frameworks applied not only carry important assumptions about how multiple-text learning happens, but also determine which processes researchers attend to.

Multiple-Text Interventions

To support students with learning from multiple texts, researchers have primarily developed and examined interventions targeting integration (e.g., Barzilai & Ka'adan, 2017; Boscolo et al., 2007; Darowski et al., 2016; Firetto & Van Meter, 2018) and source evaluation (e.g., Braasch et al., 2013; Britt & Aglinskas, 2002; De La Paz et al., 2017;

Stadtler & Bromme, 2008) to support students' multiple-text learning. Barzali and colleagues (2018) and Brante and Strømsø (2018) recently conducted systematic reviews examining the effectiveness of integration and sourcing interventions, respectively. Both generally found promising results for extant interventions, indicating that these skills can be taught with positive effects. Several themes regarding interventions (e.g., goals, delivery, dosage, duration), texts (e.g., content, genre, curation, number, mode), measurement (e.g., outcomes, strategies) and participants (e.g., age) emerged from existing multiple-text intervention studies.

Intervention themes. The goal of most interventions was to support learners' integration and/or source evaluation skills through strategy use (e.g., Barzilai & Ka'adan, 2017; Daher & Kiewra, 2016; De La Paz, 2005; Firetto, & Van Meter, 2018; Kingsley et al., 2015; Kirkpatrick & Klein, 2009; Linderholm et al., 2016; Martínez et al., 2015). Participants were often taught one or more strategies intended to facilitate strategic processing. For instance, in De La Paz's (2005) study, secondary students learned how to implement two strategies: a historical reasoning strategy and an argumentative writing strategy. The historical reasoning strategy scaffolded learners' intentional sourcing and corroboration. Students were taught to 1) examine who said or wrote the document, 2) compare details across documents, and 3) take notes on what seemed credible. Strategic argumentative writing was taught through two mnemonics: STOP (Suspend judgment, Take a side, Organize ideas, and Plan more as you write) and DARE (Develop a topic sentence, Add supporting details, Reject an argument for the other side, and End with a conclusion).

Although promoting strategic integration and/or sourcing has been the primary objective of extant interventions, some have also focused on learners' metacognition or motivation (e.g., Daher & Kiewra, 2016; Maier & Richter, 2014; Stadtler & Bromme, 2007; Stadtler & Bromme, 2008). For example, Stadtler and Bromme (2007, 2008) examined the role of metacognitive monitoring and evaluation in learning about a health topic online through the computer tool *met.a.ware*. In their (2007) study, participants were randomly assigned to four experimental conditions that received different types of metacognitive prompts (i.e., evaluation prompts, monitoring prompts, evaluation and monitoring prompts, or no prompts) or a control group (i.e., paper and pencil). Findings supported the implementation of metacognitive prompts in developing a quality documents model. In their subsequent (2008) study, participants were randomly assigned to four experimental (i.e., evaluation prompts, monitoring prompts, evaluation and monitoring prompts, no prompts) and two control groups (i.e., paper and pencil, plain text window). Across these (2007) and (2008) studies, Stadtler and Bromme found support for metacognitive prompting. While these studies were informed by existing research in metacognition, neither were explicitly grounded in SRL models.

Interestingly, multiple-text interventions were commonly delivered by the researcher or researcher-generated materials (e.g., Argelagós, & Pifarré, 2012; Britt et al., 2004; Follmer & Tise, 2022). Although teachers delivered the intervention in some studies (e.g., De La Paz, 2005; De La Paz et al., 2017; Kingsley et al., 2015; Wissinger & De La Paz, 2016), this mode of delivery was less common. This pattern suggests that more is known about multiple-text interventions delivered by researchers or researcher-generated materials than those delivered by teachers.

The dosage and duration of interventions varied and depended upon the context (i.e., laboratory, classroom). Some interventions were conducted in one (e.g., Braasch et al., 2013; Daher et al., 2016) or two (e.g., Macedo-Rouet et al., 2013) sessions, while others were administered in multiple sessions that ranged from three to weeks-long sessions (e.g., Barzilai & Ka'adan, 2017; De La Paz, 2005; De La Paz et al., 2017; Kingsley et al., 2015). Intervention duration also varied. For example, Braasch and colleagues' (2013) intervention that took place in one session lasted sixty minutes, while Kingsley and colleagues' (2015) intervention that took place across eight weeks involved about ten instructional hours.

Text themes. Students have commonly learned about content in history (e.g., Britt & Aglinskas, 2002; De La Paz, 2005; Martínez et al., 2015), STEM (e.g., Braasch et al., 2013; Firetto, & Van Meter, 2018), health and nutrition (e.g., Barzilai & Ka'adan, 2017; Delgado et al., 2020; Stadtler & Bromme, 2007), and psychology (e.g., Darowski et al., 2016; Wopereis et al., 2008) through expository texts in existing interventions. Although less common, some researchers studied students' learning about multiple content areas (e.g., Brand-Gruwel & Wopereis, 2006; Hammann & Stevens, 2003; Kammerer et al., 2016; Karimi, 2015; Macedo-Rouet et al., 2013), social/controversial issues (e.g., Follmer & Tise, 2022; González-Lamas et al., 2016; Stadtler et al., 2016), education (e.g., Lehmann et al., 2019; Segev-Miller, 2004), digital literacy (e.g., Gagnière et al., 2012), and notable people or countries (e.g., Kingsley et al., 2015). Students' learning from other types of text-based documents, such as literary texts, has been understudied within the field of multiple texts.

Interestingly, most intervention studies presented students with a pre-selected repertoire of texts. Few interventions to my knowledge allowed learners to search for and select their own texts, likely because most interventions implemented quantitative methods and controlled for as many confounding variables as possible. However, this control also reduces the ecological validity of multiple-text learning. Within educational and non-educational contexts, learners often search for and select their own texts.

In prior interventions, the number and mode of texts participants learned from varied. The number of texts ranged from two (e.g., Firetto & Van Meter, 2018; Follmer & Tise, 2022) to eight (e.g., González-Lamas et al., 2016; Mason et al., 2014; Stadtler et al., 2016) to as many as thirty (e.g., Karimi, 2015). While the scope and extensiveness of interventions certainly played a role, the number of texts also matters, as it influences task complexity. Interestingly but perhaps unsurprisingly, participants often learned from digital texts (e.g., Kammerer et al., 2016; Maier & Richter, 2014; Stadtler & Bromme, 2007), although printed, paper-based texts were also studied (e.g., Lehmann et al., 2019; Stadtler et al., 2016; Wissinger & De La Paz, 2016).

Measurement themes. Knowledge, integration, and sourcing were the primary outcome variables in intervention studies. Knowledge was commonly measured with a researcher-generated multiple-choice assessment (e.g., Delgado et al., 2020; Firetto & Van Meter, 2018). Prior topic knowledge was also measured through participants' responses to an open-ended question about the given content (e.g., Barzilai & Ka'adan, 2017; Mason et al., 2014) and a combination of closed- and open-ended items (e.g., Lehmann et al., 2019). In addition, various types of knowledge were measured, including knowledge of facts (i.e., declarative knowledge), concepts (i.e., conceptual knowledge), procedures (i.e., procedural knowledge), and relationships. For example, Hammann and Stevens (2003) measured learners' declarative knowledge in a 24-item instrument based upon information from the provided texts. In addition, Delgado and colleagues (2020) measured prior knowledge with a 24-item instrument measuring learners' knowledge of facts and concepts about sun exposure and health. Similarly, Daher and Kiewra (2016) included three types of items in their achievement test: facts, concepts, and relationships. However, in other studies, the types of knowledge measured were not specified (e.g., Firetto & Van Meter, 2018; Lehmann et al., 2019).

In addition, integration was previously measured with several strategies, such as scoring learners' writing in response to a single prompt (e.g., Barzilai et al., 2021; Wissinger & De La Paz, 2016). Another strategy included assessing learners' writing in response to a series of open-ended questions, several of which indirectly and others that directly required integration (e.g., Barzilai & Ka'adan, 2017; Bråten et al., 2014). Similarly, sourcing was measured in various ways, including explicit citations in writing (e.g., Britt et al., 2004).

In addition, some studies assessed learners' strategy use. Bråten and Strømsø's (2011) Multiple-Text Strategy Inventory (MTSI) has been widely used in the multiple-text literature. The MTSI measures two types of strategy use in its subscales: cross-text elaboration and accumulation. Cross-text elaboration strategies facilitate deeper-level processing of content through processes like comparing and integrating content across texts. Accumulation strategies facilitate lower-level processing of content through processes like memorization. Researchers adapted the few content-specific items regarding climate change in the MTSI to align with their study's content (e.g., Follmer & Tise, 2022).

Participant themes. Secondary and undergraduate students were studied the most in multiple-text intervention studies (e.g., Barzilai & Ka'adan, 2017; Boscolo et al., 2007; Darowski et al., 2016; De La Paz et al., 2017; Firetto, & Van Meter, 2018; Follmer & Tise, 2022; González-Lamas, 2016; Lehmann et al., 2019; Martínez et al., 2015). However, some researchers worked with elementary students (e.g., Kingsley et al., 2015; Macedo-Rouet et al., 2013 Zhang & Duke, 2011), vocational students (e.g., Stadtler et al., 2016), and a mix of undergraduate and adult undergraduate students (e.g., Delgado et al., 2020). For instance, Kingsley and colleagues' (2015) study promoted fifth-grade students' 21st century online research skills through an intervention focused on integration and source evaluation skills.

Limitations to the Current Approach

Although extant research investigating multiple-text interventions has made significant progress in examining how to support students' learning, there are important limitations to the current approach. These limitations pertain to the lack of attention to self-regulated learning (SRL) (Denton et al., 2020), or how learners direct their strategy use, metacognition, and motivation toward a learning goal (Zimmerman, 2001).

First, although multiple-text interventions commonly address strategy use and strategic processing, they do not approach instruction from an SRL perspective. Individual SRL components, like strategy use, metacognition, and motivation, may be targeted or measured in multiple-text studies, but most studies do not ground their interventions in SRL models. As a result, SRL is not addressed as a whole, resulting in a lack of attention to important underlying assumptions about and processes critical to SRL. Similarly, findings about the effectiveness of SRL instruction are generally not applied, since instruction is not approached from this lens. For example, strategy instruction grounded in SRL would include components like what, how, why, and when/where. Although multiple-text learning interventions commonly target declarative (i.e., what) and procedural (i.e., how) knowledge, they generally do not target conditional knowledge (i.e., why, when/where). Supporting learners' conditional knowledge regarding multiple-text strategies is essential to promote application and transfer of effective strategies.

Second, multiple-text models generally oversimplify SRL. The goal of a multiple-text model or framework is to represent the processes of multiple-text learning. However, multiple-text learning tasks are complex and necessitate learners' SRL or goal-directed processing. Across the major models and frameworks discussed, SRL is neglected in the documents model, represented as an internal resource in MD-TRACE, specified during the execution phase of the IF-MT, and depicted as reader resources that interact with other processes while reading in RESOLV. The descriptions fail to capture the highly cyclical, ongoing nature of SRL that is essential for successful multiple-text learning. SRL in multiple-text learning is not simply an internal resource or applied while executing a learning task. Instead, SRL encompasses interactive processes that the learner controls and monitors before, during, and after multiple-text learning.

Third, multiple-text interventions often neglect the role of metacognitive (e.g., planning, monitoring, evaluating) and motivational (e.g., self-efficacy) processes. Metacognition and motivation are critical to learning. Learners who are more metacognitively and motivationally engaged are oftentimes more successful in their academic performance. For example, one would expect metacognitive processes like planning, monitoring, and evaluation to be essential for and promote successful multiple-text learning. Similarly, although prior research has established that motivation impacts academic performance, important constructs like self-efficacy have been understudied in this area. Learners' self-efficacy, or their beliefs about their abilities to complete specific tasks (Bandura, 1986), has been established as a strong predictor for academic performance. Attention to metacognitive and motivational constructs is essential to better understand and promote students' multiple-text learning.

Self-Regulated Learning

SRL is the cyclical, ongoing processes of intentionally and actively directing one's strategy use, metacognition, and motivation toward a learning goal (Zimmerman, 2001). Importantly, SRL is not something that "happens" to learners (Zimmerman, 2001); it refers to self-directive processes that learners implement proactively when working toward attaining their goals (Schunk, 2001; Zimmerman, 2001). Although different models of SRL exist and vary in their representation of how processes unfold (Panadero, 2017; Puustinen & Pulkkinen, 2001), most scholars agree that academic strategy use, metacognition, and motivation are critical elements of SRL (Sperling et al., 2004).

Furthermore, many scholars agree that through intentional control, students can improve their own learning, structure their learning environment productively, and actively select needed instruction (Zimmerman, 2001). Self-regulated learners engage in planning, monitoring, and evaluation processes throughout their learning. They select and implement strategies, track their comprehension and performance, make adjustments when necessary, and reflect on their learning (Winne, 2001).

Research shows that promoting learners' SRL positively impacts their academic performance (Dignath & Büttner, 2008; Pintrich, 2000). Learners' regulatory activities can facilitate improved academic performance, even when considering personal and contextual factors (Pintrich, 2004). By directing their own strategy use, metacognition, and motivation, learners can positively impact their achievement. To capture the potential for regulation across generally agreed upon SRL phases, Pintrich (2004) proposed a conceptual framework for measuring SRL in college students and to facilitate additional research. The potential phases are crossed by areas for regulation in the framework. Phases include 1) forethought, planning, and activation, 2) monitoring, 3) control, and 4) reflection and reaction. Areas for regulation include cognition, motivation/affect, behavior, and context. Through a variety of regulatory processes across SRL phases, learners facilitate enhanced learning outcomes for themselves. For instance, in the forethought, planning, and activation phase, learners might engage in cognitive regulation by activating prior content knowledge or setting goals. In addition, learners might engage in behavioral regulation during the control phase by increasing or decreasing effort or engaging in help-seeking behavior.

Importantly, however, SRL is also context specific (Cleary et al., 2012; Hadwin et al., 2001). Effective regulatory processes vary depending upon the given domain and task, as evidenced by many effective SRL interventions providing instruction within a specific domain (e.g., van Houten-Schat et al., 2018; Wang & Sperling, 2020). Similarly, students also report applying different strategies, using different resources, and setting different goals in various contexts (Hadwin et al., 2001). Scholars have attempted to capture the context-specific nature of SRL through measurement strategies like SRL microanalytic protocols (e.g., Cleary et al. 2012). Microanalytic protocols leverage structured interviews as a method to assess learners' ongoing, cyclical SRL processes as they unfold in tasks and activities.

Strategy Use

Academic strategies refer to processes aligned with task requirements that learners execute to enhance their learning and performance (Pressley et al., 1989). According to Alexander and colleagues (1998), strategies are also "procedural, purposeful, effortful, willful, essential, and facilitative" (p. 130). Importantly, strategic behavior is distinct from skillful behavior; strategy use is characterized by effortful, intentional behavior, whereas skills are procedures that tend to be implemented with more automaticity and less intentionality (Alexander et al., 1998; Dole et al., 1991). Dole and colleagues (1991) further distinguished strategies from skills through the critical role of reasoning and flexibility in the former. Thus, inherent to strategy use is the role of the learner's control and monitoring processes, both of which are central to SRL.

Strategies are often classified by the processes they target, including cognitive, metacognitive, management, and motivational (Broadbent & Poon, 2015). Cognitive strategies include elaboration, rehearsal, and organization. Elaborative processing strategies support making connections between new content and prior knowledge, such as elaborative interrogation, self-explanation, and learner-generated examples and drawings (Dornisch et al, 2011; Dunlosky et al., 2013; Sperling et al., 2016). Rehearsal strategies are those learners employ to help encode information into long-term memory, such as repeating information. Organizational strategies help learners structure material to make meaning and generate connections among content. Metacognitive strategies include planning, monitoring, and evaluation strategies that one uses throughout learning. Management strategies enhance learning conditions by targeting oneself, others, or the environment. Learners use motivational strategies to initiate and sustain behavior, such as generating study session goals.

Research demonstrates that strategy use can be taught effectively and positively influence learning outcomes. For example, strategy use has been taught in a variety of contexts, including laboratory (e.g., Nietfeld & Schraw, 2002), classroom (e.g., Tise et al., 2023), and game-based learning environments (e.g., Sperling et al., 2022). Research also shows that learning strategy instruction has positive effects on academic performance (e.g., Dignath et al., 2008; Donker et al., 2014). For example, in their (2014) meta-analysis, Donker and colleagues reviewed the effects of studies attempting to promote SRL through academic strategy instruction at the primary and secondary education levels. The included interventions were conducted in a variety of domains, including mathematics, reading, science, and writing. The interventions were also categorized by the type of strategy (i.e., cognitive, metacognitive, and management), motivational aspects, and metacognitive knowledge addressed. Donker and colleagues found that intervention effect sizes indicated general effectiveness for all types of interventions. However, a more detailed analysis revealed that the cognitive strategy rehearsal, metacognitive strategy planning, motivational aspects task value and goal orientation, and metacognitive knowledge (general) were particularly effective for enhancing student performance. Overall, findings indicated that a variety of strategies that target all SRL components were effective for supporting students' academic performance.

Metacognition

Metacognition is commonly described as thinking about thinking (Schraw et al. 2000). More specifically, metacognition is knowledge and regulation of cognition (Schraw & Dennison, 1994; Sperling et al., 2004). Knowledge of cognition (KOC) captures the reflective nature of metacognition, while regulation of cognition (ROC) refers to the control processes. KOC encompasses knowledge about oneself and strategies (i.e., declarative), how to use strategies (i.e., procedural), and when and why to use strategies (i.e., conditional). ROC encompasses 35 regulatory processes learners exert to control their own learning, including planning, monitoring, and evaluating. Monitoring is a critical component of metacognition; it refers to processes that generate feedback about the effectiveness of activities occurring throughout the learning task (Schraw et al., 2000).

A significant body of research has demonstrated the positive effects of metacognition on numerous outcomes. For example, enhanced metacognition can support students' performance in reading (e.g., McKeown & Beck, 2009), writing (e.g., Harris et al., 2009), science (e.g., White et al., 2009), mathematics (e.g., Wang & Sperling, 2020), and creative problem solving (e.g., Hargrove & Nietfeld, 2015). In addition, research has demonstrated that metacognitive knowledge and regulatory capacities can be effectively taught (Broadbent & Poon, 2015). Veenman and colleagues (2006) described three major components required for successful metacognitive instruction, including integrating the instruction into the content, expressing why the instruction matters, and offering enough practice to support appropriate application. In other words, metacognitive instruction should target what, when, why, and how (Veenman et al., 2006). Scholars have examined metacognitive interventions in science (e.g., Peters & Kitsantas, 2010), mathematics (e.g., Hacker et al., 2019), and reading (Haller et al., 1988), to name a few, consistently finding positive effects on various learning outcomes.

Scholars have noted the difficulty in measuring metacognition due to task, test, and person constraints (Schraw et al., 2000). However, numerous measurement strategies exist. Varied approaches include think-alouds, self-report measures, and subjective performance judgments (Schraw et al., 2000). Self-report measures remain the most widely used. Schraw and Dennison's (1994) Metacognitive Awareness Inventory (MAI) is the most widely implemented tool. The MAI is a 52-item self-report scale that measures adolescents and adults' metacognitive awareness through KOC and ROC subscales and includes the previously discussed subcomponents. More recently, Harrison and Vallin (2018) validated a shortened version of the MAI that includes 19 items.

Metacognitive judgments are also often used as a measure of metacognition. Metacognitive judgments are assessments one makes about their own learning and performance (Schraw, 2009b). In his (2009b) chapter, Schraw provided a taxonomy of various calibration judgments organized by the time of judgment, including prospective, concurrent, and retrospective. In relation to time of testing, prospective judgments are made before (e.g., Feeling of Knowing; FOK), concurrent are made during (e.g., Online Confidence Judgments), and retrospective are made after (e.g., Ease of Learning/Solution). According to Schraw (2009b), most metacognitive monitoring studies examine the relationship between confidence judgments and performance. To assess metacognitive monitoring specifically, several measures have been used. Schraw (2009a) described a conceptual analysis of five indices of metacognitive monitoring that can be calculated from judgments made on a 1-100 unit confidence scale, including absolute accuracy, relative accuracy, bias, scatter, and discrimination.

Motivation

Motivation refers to what sparks and sustains behavior and is essential in SRL. Motivation is required to initiate and maintain not only learning, but also strategy use. As a construct, motivation has been operationalized in a variety of ways. In their (2000) review, Murphy and Alexander explored and identified major terms used in the study of achievement motivation. Two particularly impactful motivational constructs in the context of SRL include achievement goals and self-efficacy.

Achievement goals refer to learners' competence and how it manifests in two dimensions: definition and valence (Elliot & McGregor, 2001). Competence is defined by the ways learners evaluate their performance: absolute or intrapersonal (i.e., mastery) or normative (i.e., performance) standards. Competence is valanced by learners' perceptions of positive outcomes (i.e., approach success) or negative outcomes (i.e., avoid failure). Mastery and performance goals are much like Dweck's work on mindset (e.g., Dweck, 2006; Dweck & Yeager, 2019), which differentiates between growth (i.e., incremental) and fixed (i.e., entity) orientations about the nature of intelligence. Learners who view intelligence as malleable and have more adaptive, resilient orientations toward learning and failure possess more growth-oriented mindsets. However, those who view intelligence as stable and unchangeable and view learning and failure as reflections of their self-worth possess more fixed-oriented mindsets. Findings indicate that differences in thinking and behavior emerge depending upon achievement goal and mindset orientations (e.g., Dweck & Yeager, 2019; Elliot & McGregor, 2001). Learners with mastery or growth orientations differ from learners with more performance or fixed orientations regarding how they view concepts like success, ability, and failure. For example, a student with a performance approach goal orientation will likely evaluate their success based upon their performance relative to others. As a result, given that the student wants to succeed and evaluates success relative to others, this student will be motivated and is likely to achieve at a high level.

Self-efficacy is another motivational construct, which has also significantly influenced the SRL literature. A major concept from Bandura's (1986) social cognitive theory, self-efficacy refers to people's beliefs about their perceived capacities to complete specific performances. Bandura conceptualized four major influences on self-efficacy: mastery experiences, vicarious experiences, physiological experiences, and social persuasion. Research shows that self-efficacy levels impact learners' behavior (Usher & Pajares, 2008). Those with higher self-efficacy tend to approach more tasks, demonstrate more adaptive behavior and performance attributions, and apply more effective strategies. On the other hand, those with lower self-efficacy are less inclined to approach tasks, demonstrate more maladaptive behavior and performance attributions, and fail to apply effective strategies. Importantly, self-efficacy is a powerful predictor of student academic achievement across various levels and domains (Pajares, 2003; Pajares & Urdan, 2006; Usher & Pajares, 2008).

Much like existing interventions focused on supporting strategy use and metacognition, respectively, interventions targeting motivation have also shown positive effects for learners. In their (2016) meta-analysis, Lazowski and Hulleman found support for the effectiveness of motivation interventions grounded in a wide range of theories and frameworks, including achievement goals, self-efficacy, interest, and expectancy-value. The average effect size for those included interventions was 0.49 (Cohen's *d*).

Self-Regulated Learning Interventions

Overall, SRL research has demonstrated the positive effects of SRL interventions on numerous outcomes, such as strategy use, motivation, metacognition, and achievement. In their (2008) meta-analysis, Dignath and colleagues studied the effectiveness of SRL interventions for primary school students. The overall mean effect size across studies was 0.69 (*Cohen's d).* Dignath and Büttner (2008) followed this meta-analysis and examined the effects of SRL interventions conducted at both the primary and secondary education levels. They reported an average effect size of 0.69 (*Cohen's* d) for SRL interventions. Additionally, more specific meta-analyses and reviews of SRL interventions have been conducted in a variety of contexts, such as mathematics classrooms (Wang & Sperling, 2020), clinical contexts (van Houten-Schat et al., 2018), online learning environments and massive open online courses (Wong et al., 2019), and higher education (Jansen et al., 2019). Thus, existing meta-analyses and reviews support the effectiveness of SRL interventions across contexts, which not only demonstrate positive effects on SRL but also academic performance.

Approaching multiple-text interventions from an SRL perspective would allow researchers to support students' goal-directed, autonomous learning within this context. Although interventions supporting integration and source evaluation target students' skills in multiple-text learning and often do so through strategic processing, they do not explicitly focus on SRL components as a whole or ground their work in SRL models. Similarly, although some scholars explicitly examined SRL components like metacognition in multiple-text interventions (e.g., Stadtler & Bromme, 2007; Stadtler & Bromme, 2008), they did not ground interventions in SRL models.

The Current Study

The purpose of the current study was to contribute to the rich body of multiple-text literature. I sought to examine a metacognitive prompting intervention grounded in

Winne and Hadwin's (1998) model of SRL to support students' learning. My goal was to study how the intervention would impact outcomes related to multiple-text learning and SRL, individually and in combination (i.e., knowledge, integration, metacognition, and strategy use). Using a pretest-posttest design with a metacognitive prompting with integration reminder (MP+I) intervention condition, a metacognitive prompting (MP) intervention condition, and a control condition, I hypothesized that the treatment conditions would outperform the control on the outcomes of interest**.**

Theoretical Framework

The current study was guided by Winne and Hadwin's (1998) model of SRL. My goal was to ground the intervention in an SRL model while attending to the unique nature of multiple-text reading. An important underlying assumption and key component of Winne and Hadwin's model is that metacognitive monitoring is centered as the critical process that facilitates SRL overall. They proposed that SRL unfolds in four phases: 1) task definition, 2) goal setting and planning, 3) executing goals and plans through study strategies, and 4) metacognitively adapting studying. Within each phase, several processes grounded in information-processing theory (Atkinson, & Shiffrin, 1968; Mayer, 2012; Simon, 1979) are assumed to occur. Winne and Hadwin (1998) describe these processes with the acronym COPES, or a person's conditions, operations, products, evaluations, and standards. Conditions refer to those cognitive resources (e.g., motivational factors and orientations, knowledge of study tactics and strategies) and task circumstances (e.g., time, instructional cues) available to the learner. Operations refer to those processes the learner uses to manipulate information, which Winne and Hadwin referred to as SMART processes. SMART processes include searching, monitoring, assembling, rehearsing, and translating and result in cognitive products, or information, for each of the four phases. To compare such products against standards, the learner engages in cognitive evaluations, which are made possible through monitoring. Standards refer to those criteria that the learner uses to establish their goal, while evaluations refer to the judgments the learner uses to assess the extent to which they have met such standards.

In the current study, prompts in both treatment conditions were developed to target the four phases and the COPES processes that occur within each phase. The MP condition was developed to examine the role of general metacognitive prompting in enhancing the outcomes of interest. The MP+I condition, however, included language to make the task conditions explicit. Since research shows that learners often struggle to integrate information independently, the MP+I condition sought to address this through enhanced instructional cues.

Research Questions

The purpose of this study was to examine the effects of metacognitive prompting that invokes integration task goals (MP+I) and metacognitive prompting alone (MP) compared to a control condition that did not receive prompts. I was particularly interested in examining the impacts on relevant multiple-text and SRL outcomes, including knowledge, integration, metacognition, and strategy use. Thus, the following research questions were developed to target the purpose of the study:

1. Does learners' knowledge, as measured with a researcher-generated knowledge assessment, differ based upon prompting condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition?
2. Does learners' metacognition, as measured with a metacognitive awareness instrument and confidence judgment ratings, differ based upon prompting condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition?
3. Does learners' integration, as measured with an essay composed in response to a researcher-generated prompt, differ based upon prompting condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition?
4. Does learners' strategy use, as measured with a multiple-text strategy use instrument, differ based upon prompting condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition?

Does learners' knowledge, as measured with a researcher-generated knowledge assessment, differ based upon prompting condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition? I expected significant differences on the knowledge instrument by condition. It was hypothesized that the treatment conditions would be significantly different from the control and one another. Since learners in the MP+I group were reminded about their integration task goals, I predicted that this instruction would facilitate enhanced intra- and inter-textual connections, thus supporting knowledge construction. The expected pattern of results was MP+I>MP>Control.

Does learners' metacognition, as measured with a metacognitive awareness instrument and confidence judgment ratings, differ based upon prompting condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition? I expected significant differences by condition on the three measures of metacognition: the metacognitive awareness instrument and two indices of metacognitive monitoring calculated from confidence judgments (i.e., bias and absolute accuracy). For this question, I hypothesized that the treatment conditions would be significantly different from the control and one another. Given the enhanced task goal cues in the MP+I condition, I expected them to support improved metacognitive capabilities. The expected pattern of results was MP+I>MP>Control.

Does learners' integration, as measured with an essay composed in response to a researcher-generated prompt, differ based upon prompting condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition? I expected significant differences in learners' integration on the essay in response to the researcher-generated prompt. Because the prompting in both treatment groups targeted learners' self-regulation and metacognitive monitoring, I predicted that the treatment conditions would be significantly different from the control. However, because the prompting in the MP+I group specifically invoked integration task goals, I also hypothesized that the MP+I group would be significantly different from the MP group. The expected pattern of results was MP+I>MP>Control.

Does learners' strategy use, as measured with a multiple-text strategy use instrument, differ based upon prompting condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition? I expected significant differences in learners' strategy use on the multiple-text strategy use instrument. Because the prompting in both treatment conditions targeted learners' self-regulation and metacognitive monitoring, I predicted that the treatment groups would be significantly different from the control. However, because the prompting in the MP+I group specifically invoked integration task goals, I hypothesized that the MP+I group would be significantly different from the MP group. Such task cues were expected to facilitate the implementation of more appropriate strategies for the task. The expected pattern of results was MP+I>MP>Control.

Chapter 2

Methodology

Participants

Participants were 182 undergraduate students enrolled in an introductory educational psychology or education theory and policy course. Most participants identified as female (*n*=148, 81.3%) and white (*n*=155, 85.2%). In addition, most were in their first (*n*=79, 43.4%) or second (*n*=69, 37.9%) year of undergraduate studies in the College of Education (*n*=119, 65.4%). Mean self-reported age was 19.01 (*SD*=1.09) and mean self-reported college grade-point average (GPA) was 3.49 (*SD*=.40, included *n*=95). Those 87 participants not included in the mean GPA reported they did not know their GPA or did not yet have a GPA. See Table 2-1 for demographic information.

Table **2-1:** Demographic information

Characteristic	*n*	%
Gender		
Nonbinary	2	1.1%
Female	148	81.3%
Male	31	17.0%
Nonbinary Male	1	0.5%
Race/Ethnicity		
Hispanic/Latinx	2	1.1%
White	155	85.2%
Black or African American	4	2.2%
Asian	11	6.0%
Prefer not to answer	3	1.6%
Hispanic/Latinx and White	7	3.8%
Academic Standing		
First-year student	79	43.4%
Second-year student	69	37.9%
Third-year student	24	13.2%

Fourth-year student	9	4.9%
Other	1	0.5%
Academic College		
College of Education	119	65.4%
Other	63	34.6%

Design

This study employed a pretest-posttest design with a metacognitive prompting with integration reminder (MP+I) treatment condition, a metacognitive prompting (MP) treatment condition, and a control condition. After completing pretest measures, participants were randomly assigned to conditions. The key independent variable in this study was the manipulation of intervention prompts across conditions. The MP+I and MP conditions received prompts throughout their learning task, while the control condition did not receive any. Key outcome variables in this study included knowledge, metacognition, integration, and strategy use.

Materials

Texts

After pretest, learners across conditions were prompted to engage in the same multiple-text learning task and received the following task instructions: *Read the writing prompt, use as much time to learn from the two provided texts about the learning styles myth, and write an essay using what was learned and referencing the provided texts.*

Since the intervention prompts were not designed to support the negotiation of conflicting sources or source evaluation, I selected texts that explicitly debunked the learning styles myth. Prior research has established the effectiveness of using refutation texts, especially in the context of psychology misconceptions (Lassonde et al., 2016). The refutation texts in this study were similar in length and readability levels (See Table 2-2). In line with prior research and due to the texts' individual and combined length, I selected two texts for this study. Although there was some content overlap, each text offered unique information, lending themselves well to an integration task.

Importantly, however, the two texts used in the current study were likely challenging for the participants given the length and readability level. A major assumption in the design for the current study was that the participants would be able to engage with lengthy, college-level texts. Given that most participants were first- or second-year undergraduate students, however, many of them likely did not have substantial experience with such challenging texts. Related implications are explored in greater detail in the *Discussion*.

Table **2-2**: Texts

Text	Gist	Word Count	Flesch-Kincaid Grade Level
The Myth of Learning Styles	Debunk the myth	~2700 words	11.2
The Stubborn Myth of "Learning Styles"	Debunk the myth	~2400 words	13.8

Intervention

The intervention materials in this study included metacognitive prompts that were grounded in and targeted each stage of Winne and Hadwin's (1998) model of SRL. The number, type, and placement of prompts in the learning task were held constant across the MP and MP+I treatment conditions. Although both treatment conditions received SRL prompts, the MP+I condition received integration task goal reminders, while the MP condition prompts made no mention about integration. See Table 2-3 for the metacognitive prompts.

Table **2-3:** Metacognitive prompts

SRL Model Phase	Prompt Type	Prompt Placement	MP Prompt	MP+I Prompt
Task Definition	Short response	After reading the learning task instructions	In your own words, describe your learning task.	In your own words, describe your learning task that is focused on making connections across texts.
Goal Setting and Planning	Short response	After reading the learning task instructions	What strategies will you implement to meet your goals?	Knowing that your task is focused on making connections across texts, what strategies will you implement to meet your goals?
Enacting Tactics	Reminder	While reading text 1, reading text 2, and writing	Remember to implement the strategies you described.	Remember to implement the strategies you described as you try to make connections across texts.
	Short response	While reading text 1	How does this text relate to what you already know?	Your task is focused on making connections across texts, but how does this text relate to what you already know?
	Short response	While reading text 2	How does this text relate to what you already know?	How does this text relate to what you already know and learned in the previous text?

Monitoring	Rating	While reading text 1 While reading text 2	Rate how confident you are that you are comprehending the text you just read.	Rate how confident you are that you are comprehending the text you just read.
	Rhetorical question	While reading text 1, reading text 2, and writing	Assess how well your strategies are working.	Assess how well your strategies are working to make connections across texts.
	Rhetorical question	While reading text 1, reading text 2, and writing	Do you need to make any changes to your strategies?	Do you need to make any changes to your strategies to help with making these connections?
Evaluation	Rating	After writing	Rate how well you think you did on your learning task.	Rate how well you think you did on your learning task of making connections across texts.
	Short response	After writing	What will you do again in future similar tasks, and what will you do differently?	What will you do again in future integration tasks, and what will you do differently?

Measures

I measured learners' knowledge, metacognition, integration, strategy use, and demographic information in the current study. All reliability coefficients for implemented measures are internal consistency measures reported as Cronbach's alpha.

Knowledge

Learners originally completed a 19-item knowledge assessment constructed by the research team at pretest and posttest. However, one item was removed due to a discrepancy in the item stem between pretest and posttest. Thus, I report on the adjusted 18-item measure, which was administered in a four-option multiple-choice with one correct answer format. Consistent with extant research measuring knowledge (e.g., Daher & Kiewra, 2016; Delgado et al., 2020; Hammann & Stevens, 2003), the instrument measured learners' declarative (n=11) and conceptual (n=7) knowledge about learning and the learning styles myth. Declarative items measured learners' knowledge of facts, while conceptual items measured learners' application of the facts to novel scenarios. Importantly, the facts in the declarative items were addressed in the texts, while the scenarios in the conceptual items were not. A declarative item was, *Teaching to students' learning styles: a) does not result in deep learning, b) improves learning outcomes, c) is not supported by research, or d) makes learning easier for students*. A conceptual item was, *Mr. Wright teaches Algebra II. He is preparing for the new school year and wants to meet his students' needs. Mr. Wright should: a) start the school year with a cumulative exam, b) assess his students' mathematical knowledge, c) assume his students' background knowledge, or d) survey his students for their learning styles.*

Although the knowledge assessment demonstrated weak reliability at pretest (α=.30), it demonstrated stronger psychometric properties at posttest (α=.72). See Appendix A for the knowledge measure. To further analyze the knowledge measure, I examined the item difficulties at pretest and posttest. See Table 2-4 for a summary of the item means and standard deviations. At pretest, the item difficulties ranged from .07 to .84, and few item means were close to a value of .50. Although there was a range in the item means, most items were either very difficult (e.g., item two) or very easy (e.g., item three) for the participants. Thus, the items in the knowledge measure did not adequately differentiate among individuals at pretest. However, at posttest, the item difficulties ranged from .32 to 75, and more item means were closer to .50. Although some items were difficult (e.g., item 18) or easy (e.g., three) at posttest, most of them performed well and better compared to pretest. Thus, the items in the knowledge measure performed better at differentiating among students at posttest.

Table **2-4**: Knowledge item difficulties

Item	Pre *M* (*SD*)	Post *M* (*SD*)
1	.65 (.48)	.45 (.50)
2	.07 (.26)	.43 (.50)
3	.84 (.37)	.75 (.44)
4	.20 (.40)	.43 (.50)
5	.47 (.50)	.34 (.48)
6	.47 (.50)	.53 (.50)
7	.55 (.50)	.58 (.50)
8	.78 (.42)	.72 (.45)
9	.34 (.48)	.56 (.50)
10	.41 (.49)	.40 (.49)
11	.17 (.38)	.49 (.50)
12	.26 (44)	.56 (.50)
14	.14 (.35)	.33 (.47)
15	.26 (.44)	.56 (.50)
16	.21 (.41)	.35 (.48)
17	.55 (.50)	.64 (.48)
18	.43 (.50)	.32 (.47)
19	.12 (.33)	.47 (.50)

The differences in item difficulties between pretest and posttest could explain the internal reliability coefficient changes from α=.30 to α=.72 from pretest to posttest, respectively. At pretest, most items were either very difficult or too easy, with most items on the more challenging side. As a result, participants could have guessed, rendering the items less stable. After engaging with the texts, participants would have learned more about the learning styles myth. With more knowledge, the participants would not have had to guess as much. As a result, the consistency of responses would have been more stable at posttest.

Metacognition

Metacognitive awareness. At pretest and posttest, learners completed the shortened 19-item Metacognitive Awareness Inventory (MAI) items on a five-point scale (*1=Not at all typical of me, 5=Very typical of me*) (Harrison & Vallin, 2018; Schraw & Dennison, 1994). The MAI assesses learners' knowledge of cognition (KOC) and regulation of cognition (ROC). The KOC subscale includes eight items that measure learners' declarative, procedural, and conditional knowledge. The ROC subscale includes eleven items that measure learners' planning, information management strategies, monitoring, evaluation, and debugging strategies. Harrison and Vallin (2018) reported sound psychometric properties of the shortened MAI for the KOC subscale (α=.80) and ROC subscale (α=.84). In the current study, the shortened MAI demonstrated strong psychometric properties. At pretest, reliability coefficients were .88, .79, and .84 for the overall instrument, the KOC subscale, and the ROC subscale, respectively. At posttest, reliability coefficients were .94, .88, and .90 for the overall instrument, the KOC subscale, and the ROC subscale, respectively.

Metacognitive monitoring. Learners completed immediate, item-level confidence judgments after each knowledge item, rating how confident they were in their response (*0=Not very confident, 100=Very confident*). Confidence judgments are an established strategy to measure learners' metacognitive monitoring (Nietfeld et al., 2005; Schraw, 2009a; Schraw, 2009b). From those raw confidence judgments, various indices of metacognitive monitoring can be calculated, such as bias and absolute accuracy (Schraw, 2009a; Schraw, 2009b). Monitoring bias is an index of learners' error in their judgment, reflecting over- or under-confidence; negative numerical values indicate under-confidence, while positive numerical values indicate over-confidence (Schraw, 2009a; Schraw, 2009b). Monitoring absolute accuracy measures learners' calibration, reflecting their accuracy in judging their performance. Monitoring absolute accuracy is commonly calculated by squaring the difference between a confidence judgment score and a performance score (Schraw, 2009a; Schraw, 2009b). As such, absolute accuracy as an index does not provide information regarding the direction of error. Using learners' raw item-level confidence judgments, I calculated bias and absolute accuracy scores for individual knowledge items and mean bias and absolute accuracy scores for the knowledge measure overall at pretest and posttest (Schraw, 2009a; Schraw, 2009b).

Integration

Learners composed an essay in response to a writing prompt generated by the research team (See Appendix B). To measure learners' integration of the two texts they read, two members of the research team and I developed a rubric through an iterative process. First, informed by Perfetti and colleagues (1999) and Britt and colleagues' (1999) work on models representing situations and sources and List and colleagues' (2019) work on coding such models, we developed a rubric grounded in the documents model (Perfetti et al., 1999). This rubric scored essays on a five-point scale. Second, we randomly selected ten essays and tested the rubric. Revisions were made to the rubric to capture the variance in students' writing, because many essays did not fit into the original levels we created. Next, we re-scored the essays using the revised rubric and noted additional scoring issues to address. One relevant issue included consistency in distinguishing between irrelevant and relevant responses. In addition, another included distinguishing between qualitatively different relevant responses. Some responses were tangentially relevant while other responses were clearly relevant but lacked textual support. After that, we adjusted the rubric to account for the necessary additional levels for scoring. Our team re-scored and reviewed the essays to examine how well the updated rubric functioned. See Appendix C for the final rubric. Throughout the rubric development and scoring process, any disagreement in scoring was resolved through discussion.

After conducting initial analyses with the original rubric reported in Appendix C, the research team further examined the data with a revised, collapsed version of the rubric. See Appendix D for the collapsed rubric. In this rubric, three levels of responses were distinguished. The lowest possible score (i.e., 0) represented those responses that were missing or irrelevant, tangentially relevant, or relevant but lacking textual support. The next best score (i.e., 1) reflected those essays that used content from one text or both texts without integration. The highest possible score (i.e., 2) captured those essays that integrated the content with or without referring to the specific texts.

Collapsing the rubric accounted for the distribution of scores better. In the original rubric, there were some scores that accounted for very few responses. See Table 2-5 for a breakdown of the scores for each rubric.

Table **2-5:** Rubric score breakdown

Original Rubric			Collapsed Rubric		
Score	*n*	%	Score	*n*	%
0	29	15.9%	0	88	48.4%
1	6	3.3%	1	57	31.3%
2	53	29.1%	2	37	20.3%
3	48	26.4%			
4	9	4.9%			
5	3	1.6%			
6	34	18.7%			

Strategy Use

Learners completed an adapted version of Bråten and Strømsø's (2011) Multiple-Text Strategy Inventory (MTSI). In line with the instrument's development and intended uses, learners completed the MTSI at posttest only and rated the extent to which they used each strategy during the study on a 10-point scale (*1=Not at all, 10=To a very large extent*). The MTSI measures two types of multiple-text strategy use: cross-text elaboration and accumulation. Consistent with previous practice (e.g., Follmer and Tise, 2022), I slightly revised six items to match the texts' focus on debunking the learning styles myth to align the MTSI with the content-specific references in the items. For example, one item developed by Bråten and Strømsø (2011) was, *I tried to understand the issues concerning climate by comparing the content of the different texts*, and I changed it to, *I tried to understand the issues concerning learning styles by comparing the content of the different materials*. Bråten and Strømsø (2011) reported strong reliability coefficients of .88 and .82 for the MTSI's cross-text elaboration and accumulation subscales, respectively. In this study, the MTSI demonstrated strong psychometric properties, with reliability coefficients of .96, .93, and .91 for the instrument overall, the cross-text elaboration subscale, and the accumulation subscale, respectively.

Demographics

After completing the posttest measures, learners were prompted to report the following demographic information: age in years, gender, race/ethnicity, current college GPA, current academic standing, and academic college.

Procedure

Learners from a large research institution in the United States were recruited to participate in this study. Institutional Review Board approval was obtained (STUDY00016410). I shared a recruitment flyer with course instructors, which was uploaded to the course learning management systems and delivered via an announcement for students. Learners in both courses were offered approximately 2% of extra credit as compensation for their voluntary participation. Those learners who were younger than 18 years of age or did not wish to participate were offered an alternative assignment to earn the same amount of credit.

The study took place in one session remotely through a Qualtrics survey outside of structured course time. To access the study, learners clicked on the study link provided in the research flyer. Upon entering the study, learners were prompted with the informed consent form and a downloadable copy and were informed that participation in the study implied their voluntary consent. Participation occurred in three phases: the pretest, the multiple-text learning task, and the posttest.

In the first phase, learners were prompted to complete the following pretest measures: the shortened MAI and a knowledge measure with immediate, item-level confidence judgments.

In the second phase, learners were randomly assigned to conditions and directed to the multiple-text learning task. Across conditions, the task's structure and sequence were held constant. First, learners were presented with the following instructions: 1) read the writing prompt, 2) take as much time to learn from the two provided texts about the learning styles myth, 3) write an essay using what you learned and including the sources you learned from in your essay, and 4) complete the final questionnaires. Importantly, learners had access to the writing prompt in this step (i.e., they read the prompt before reading the two texts). Second, students were provided with the two texts one at a time and in the same order. Third, students were prompted to compose an essay in response to the writing prompt. Throughout the learning task, the treatment conditions received their respective metacognitive prompts.

In the third phase, learners were directed to complete the following posttest measures: the shortened MAI, a knowledge measure with immediate, item-level confidence judgments, the adapted MTSI, and a demographics survey. Finally, learners were thanked for their participation and directed to a separate Qualtrics survey where they provided their information for extra credit.

Chapter 3

Results

All data were analyzed using SPSS Version 29 (IBM, 2023). Listwise deletion was used to handle missing data. To ensure no significant differences among conditions in knowledge prior to treatment, ANOVA was first conducted ($F_{(2, 179)}$=1.48, p=.23), indicating no preexisting differences. Multiple linear or ordinal regression analyses were conducted to answer the research questions in the current study. For analyses, all continuous independent variables were entered as centered independent variables, and all categorical independent variables were entered as dummy codes. Details regarding analyses and assumptions are discussed in further detail within each research question's section. Table 3-1 includes uncentered means and standard deviations for continuous measures by condition, Table 3-2 includes the medians and modes for ordinal measures by condition, and Table 3-3 includes the correlations among all continuous measures.

Table **3-1**: Uncentered means and standard deviations for continuous measures

	MP+I *n*=55		MP *n*=65		Control *n*=62	
Measure	Pre *M (SD)*	Post *M (SD)*	Pre *M (SD)*	Post *M (SD)*	Pre *M (SD)*	Post *M (SD)*
Knowledge	6.58 (2.16)	8.58 (3.78)	7.26 (2.17)	9.31 (3.53)	6.89 (2.17)	8.76 (3.66)
Metacognitive Awareness	67.60 (11.39)	69.47 (14.45)	68.94 (10.65)	72.69 (11.21)	70.13 (9.30)	72.00 (11.80)
Monitoring bias	.25 (.20)	.16 (.28)	.19 (.20)	.17 (.22)	.22 (.19)	.16 (.25)
Monitoring absolute accuracy	.35 (.11)	.33 (.13)	.32 (.09)	.29 (.12)	.32 (.09)	.30 (.12)
Multiple-text strategy use		99.45 (26.33)		108.68 (21.765)		107.39 (23.18)

Table **3-2**: Medians and modes for ordinal measures

	MP+I *n*=55		MP *n*=65		Control *n*=62	
Measure	Median	Mode	Median	Mode	Median	Mode
Original integration score	2	2	3	6	3	3
Collapsed integration score	0	0	1	0	1	0

Missing Data and Outliers

Initially, 398 responses were recorded. However, 200 were removed to account for those who did not complete the posttest (*n*=195) and duplicates (*n*=5). Implications for such levels of attrition are discussed in greater detail in the *Discussion.* Examining the 198 students included for missing data analysis, few data were missing on pretest and posttest measures. Listwise deletion was used to remove the 5% of participants (*n*=10) who had missing values. Finally, in this sample of 188 students, outliers were examined through diagnostic tests, and six participants were removed based upon high centered leverage values. Thus, the final sample size for the current study was 182 students.

Table **3-3:** Correlations among continuous variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Pre MAI	1.00								
2. Pre knowledge	.13	1.00							
3. Pre bias	.07	-.66**	1.00						
4. Pre absolute accuracy	.05	-.30**	.68**	1.00					
5. Post MAI	.74**	.16*	.04	.10	1.00				
6. Post knowledge	-.09	.36**	-.39**	-.28**	-.07	1.00			
7. Post bias	.20**	-.14	.50**	.43**	.25**	-.70**	1.00		
8. Post absolute accuracy	.08	-.21**	.34**	.42**	.18*	-.61**	.60**	1.00	
9. Post MTSI	.39**	.12	.10	.12	.55**	-.03	.33**	.17*	1.00

* $p < .05$
** $p < .01$

Research Question 1

A multiple linear regression analysis was conducted to answer the first question that addressed whether learners' knowledge differed based upon condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition. In step one, I controlled for age, gender, and race/ethnicity. In step two, I controlled for prior knowledge, prior metacognitive awareness, prior monitoring bias, and prior monitoring absolute accuracy. In step three, I entered the treatment conditions to examine their effects on learners' knowledge at posttest.

Regarding assumptions, those of normality, linearity, homoscedasticity, and independence were met. To inspect normality, I examined a Q-Q plot of unstandardized residuals and results from a test of normality (Shapiro-Wilk=.99, df=182, p=.10). I also fit a Loess curve in a scatterplot of standardized predicted values against standardized residuals. The curve fit loosely around zero and the degree of spread of the data around zero was relatively consistent across the predicted scores, indicating no obvious violations of linearity and homoscedasticity, respectively. Regarding independence, Durbin-Watson=2.23, further indicating no violations of assumptions. Furthermore, I inspected all tolerance and variance inflation factor values (VIF) and found no issues with multicollinearity when using thresholds of .25 and 4.00, respectively.

Results indicated that after controlling for variables in the first two steps, the treatment conditions in step three did not explain a significant amount of variance on knowledge at posttest ($F_{(2, 167)}$=.21, p=.81, ΔR^2=.002, R^2=.23). In addition, unstandardized coefficients were not significant for the MP+I (B=-.18, p=.78) or MP (B=.23, p=.71) conditions. Thus, results did not support the hypothesized outcome, which was that the treatment conditions would be significantly different from the control and one another.

Research Question 2

The second research question addressed whether learners' metacognition differed based upon prompting condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition. Since there were three measures of metacognition in the current study, I conducted three multiple linear regression models to examine each outcome individually.

Metacognitive Awareness

First, I examined whether learners' metacognitive awareness, as measured with the shortened MAI, differed based upon condition after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition. In the first step, I controlled for age, gender, and race/ethnicity. In step two, I controlled for prior knowledge, prior metacognitive awareness, prior monitoring bias, and prior monitoring absolute accuracy. Finally, I entered the treatment conditions in the last step to examine their effect on the shortened MAI scores.

Although the assumption of normality was not met, I found that assumptions of linearity, homoscedasticity, and independence were met. Examining the Q-Q plot of unstandardized residuals and conducting a test of normality (Shapiro-Wilk=.98, *df*=182, *p*=.01), findings indicated that data were not normally distributed. I fit a Loess curve in a scatterplot of standardized predicted values against standardized residuals; the curve fit loosely around zero and the degree of spread of the data around zero was relatively consistent across the predicted scores, indicating no obvious violations of linearity and homoscedasticity. Regarding independence, I found that Durbin-Watson=2.30, which was satisfactory. Furthermore, using thresholds of .25 for tolerance and 4.00 for VIF, I did not detect issues with multicollinearity.

Results indicated that after controlling for the variables in steps one and two, the treatment conditions in the final step did not explain a significant amount of variance on the shortened MAI scores at posttest ($F_{(2, 167)}$=.87, *p*=.42, ΔR^2=.004, R^2=.58). In addition, unstandardized coefficients were not significant for the MP+I (*B*=-.48, *p*=.77) or MP (*B*=1.49, *p*=.34) conditions. Thus, results from this analysis did not support the hypothesized outcome, which was that the treatment conditions would be significantly different from the control and from one another.

Metacognitive Monitoring Bias

My next research question addressed whether learners' metacognitive monitoring bias, as calculated from raw item-level confidence judgments, differed based upon condition. I controlled for age, gender, and race/ethnicity in step one. In the second step, I controlled for learners' prior knowledge, prior metacognitive awareness, prior monitoring bias, and prior monitoring absolute accuracy. In the last step, I entered the treatment conditions to examine their effects against the control.

Results demonstrated that assumptions of normality, linearity, homoscedasticity, and independence were met. To examine normality, I studied the Q-Q plot of unstandardized residuals and results from a test of normality (Shapiro-Wilk=.99, *df*=182, *p*=.19). In a scatterplot of standardized predicted values against standardized residuals, I fit a Loess curve and examined the degree of spread of the data around zero; results indicated no violations of linearity or homoscedasticity. The assumption of independence was not violated, as Durbin-Watson=2.43. Last, I did not detect issues with multicollinearity, as all tolerance and VIF values were acceptable when using thresholds of .25 and 4.00, respectively.

After controlling for the variables in steps one and two, results indicated that the treatment conditions in step three did not explain a significant amount of variance on monitoring bias at posttest ($F_{(2, 167)}$=.23, *p*=.80, ΔR^2=.002, R^2=.36). In addition, unstandardized coefficients were not significant for the MP+I (*B*=.002, *p*=.96) or MP (*B*=.02, *p*=.54) conditions. Thus, results did not support the hypothesis; the treatment conditions were not significantly different from the control or one another.

Metacognitive Monitoring Absolute Accuracy

My next research question addressed whether learners' metacognitive monitoring absolute accuracy, as calculated from their raw item-level confidence judgments, differed based upon condition. In step one, I controlled for age, gender, and race/ethnicity. In the second step, I controlled for several covariates, including prior knowledge, prior metacognitive awareness, prior monitoring bias, and prior monitoring absolute accuracy. In the last step, I entered the treatment conditions to compare their effects against the control.

Although the assumption of normality was not met, results indicated that those of linearity, homoscedasticity, and independence were met. Examining the Q-Q plot of unstandardized residuals and results from a test of normality (Shapiro-Wilk=.96, df=182, p<.001), I concluded that the data were not normally distributed. In a scatterplot of standardized predicted values against standardized residuals, I fit a Loess curve and examined the degree of spread of the data around zero; the curve fit loosely around zero and data were relatively consistent across the predicted scores, indicating that data satisfied linearity and homoscedasticity, respectively. I also found that Durbin-Watson=2.26, indicating no violations of independence. Finally, upon inspecting tolerance and VIF values using thresholds of .25 and 4.00, respectively, I found no issues with multicollinearity.

Results indicated that after controlling for the variables in steps one and two, the treatments conditions in step three did not explain a significant amount of variance on monitoring absolute accuracy at posttest ($F_{(2, 167)}$=.45, p=.64, ΔR^2=.004, R^2=.24). In addition, I found that unstandardized coefficients were not significant for the MP+I (B=.02, p=.50) or MP (B=-.01, p=.81) conditions. As a result, findings did not support the hypothesized outcome, which was that the treatment conditions would be significantly different from the control and one another.

Research Question 3

My third research question addressed learners' integration, as measured with their responses to the open-ended writing prompt. To answer this question, I ran two ordinal regression analyses, the first with the original rubric scale and the second with the collapsed rubric scale.

In the first analysis, I entered gender, race/ethnicity, and treatment conditions as factors and age, prior knowledge, prior metacognitive awareness, prior monitoring bias, and prior monitoring accuracy as covariates. I entered the original rubric scale as the dependent variable. Regarding the assumption of proportional lines, results from the test of parallel lines (X^2=146.30, *df*=70, *p*<.001) indicated that this assumption was violated. From the analysis, results indicated no significant differences between the initial and final models (X^2=599.03-584.11=14.92, *df*=14, *p*=.38). Regarding goodness of fit, results indicated that the model represented the data well (Pearson's X^2=1100.98, *df*=1072, *p*=.26; Deviance X^2=584.11, *df*=1072, *p*=1.00). Thus, results did not support the hypothesis; the treatment conditions were not significantly different from the control or one another.

In the second analysis, I entered the same variables as factors and covariates from the first analysis. However, I entered the collapsed rubric scale as the dependent variable. Results from the test of parallel lines (X^2=20.29, *df*=14, *p*=.12) indicated that the assumption of proportional lines was met. Like the first analysis, results indicated no significant differences between the initial and final models (X^2=378.13-358.60=19.53, *df*=14, *p*=.15). Regarding goodness of fit, results indicated that this model represented the data well (Pearson's X^2=359.60, *df*=348, *p*=.32; Deviance X^2=358.60, *df*=348, *p*=.34). Overall, results from this analysis also did not support the hypothesized outcome.

Research Question 4

My fourth research question addressed whether learners' strategy use, as measured with the adapted MTSI, differed based upon condition. In a multiple linear regression analysis, I controlled for age, gender, and race/ethnicity in step one. In step two, I controlled for several covariates, including prior knowledge, prior metacognitive awareness, prior monitoring bias, and prior monitoring absolute accuracy. Next, I entered the treatment conditions in step three.

Results indicated that the assumptions of normality, linearity, homoscedasticity, and independence were met. I examined the Q-Q plot of unstandardized residuals and results from a test of normality (Shapiro-Wilk=.99, *df*=182, *p*=.31) and found no violations of normality. Similarly, I fit a Loess curve in a scatterplot of standardized predicted values against standardized residuals and also examined the degree of spread of the data around zero; the curve fit loosely around zero, and the spread was relatively consistent across the predicted scores. Regarding independence, I found no issues, as Durbin-Watson=1.83. Finally, there were no issues with multicollinearity, as I found all tolerance and VIF values to be satisfactory using thresholds of .25 and 4.00, respectively.

Results indicated that after controlling for the variables in steps one and two, the treatment conditions in the last step three did not explain a significant amount of variance on MTSI at posttest ($F_{(2, 167)}$=2.56, p=.08, ΔR^2=.02, R^2=.24). In addition, I found that unstandardized coefficients were not significant for the MP+I (*B*=-7.02, *p*=.09) or MP (*B*=1.88, *p*=.64) conditions. Thus, results contradicted the hypothesis, which was that the treatment conditions would be significantly different from the control and one another.

Follow-Up Exploratory Analyses

Given the null findings for the planned research questions, I conducted follow-up exploratory analyses that addressed potential subscale differences and whether students benefitted from participating in the study.

I was interested in whether there might be differences on the shortened MAI and MTSI subscales. Since my analyses examined outcomes on the scales' overall scores, I decided to explore whether the prompting intervention might have had effects on regulation (i.e., ROC subscale) or cross-text elaboration (i.e., CTE subscale). However, results from multiple linear regression analyses indicated no significant differences on the shortened MAI or MTSI subscales.

In addition, I was interested in whether students benefitted from participating in the current study. Given the use of refutation texts, I expected that all students should learn, since prior research has demonstrated positive effects for such texts (e.g., Lassonde et al., 2016). I also wondered whether engaging with the refutation texts and the learning tasks might facilitate changes in metacognitive awareness for all students. Across conditions, results from paired samples t-tests indicated significant differences in knowledge ($t_{(181)}$=-7.60, p<.001) and shortened MAI scores ($t_{(181)}$=-2.54, p<.001) from pretest to posttest. Examining gains by condition for knowledge, results indicated significant differences in knowledge from pretest to posttest for the MP+I ($t_{(54)}$=-3.96, p=<.001), MP ($t_{(64)}$=-4.94, p<.001), and control ($t_{(61)}$=-4.21, p<.001) conditions. Analyzing gains by condition for shortened MAI scores, results indicated significant differences from pretest to posttest for the MP ($t_{(64)}$=-3.38, p=.001) condition but not the MP+I ($t_{(54)}$=-1.62, p=.11) or control ($t_{(61)}$=-1.89, p=.06) conditions.

Chapter 4

Discussion

Discussion

In the current study, I examined the effectiveness of a metacognitive prompting intervention grounded in Winne and Hadwin's (1998) model of SRL. The treatment conditions received metacognitive prompts with integration task goal reminders and general metacognitive prompts, respectively. To determine the effects of the intervention, I compared these groups to a control that did not receive metacognitive prompts. Overall, results suggest that the metacognitive prompts in both treatment conditions were ineffective. Results indicated that after controlling for age, gender, race/ethnicity, prior knowledge, and prior metacognition, treatment condition was not a significant predictor of the outcomes of interest. I discuss potential explanations for this overall finding in greater detail regarding each outcome below.

Although the intervention did not seem to be effective, findings demonstrated that learners across conditions benefitted from participating given the significant differences in knowledge and shortened MAI scores from pretest to posttest. A more detailed analysis revealed that knowledge also improved at the condition level from pretest to posttest. However, there were only significant differences from pretest to posttest for the MP condition on the shortened MAI. This study offers an important contribution to the multiple-text intervention literature and fruitful directions for future research.

Knowledge

The first research question asked whether participants' knowledge, as measured with the 18-item knowledge assessment, would differ based upon prompting condition. I hypothesized that after controlling for demographic variables and prior knowledge and metacognition, the treatment conditions would explain a significant amount of variance on the knowledge measure. Both treatment conditions intended to support learners' metacognition throughout their learning task, which I expected to influence knowledge. Furthermore, I expected the MP+I condition to be significantly different from the MP condition. The MP+I condition specifically offered more explicit instructional cues about learners' integration task. I expected the cues to facilitate enhanced intra- and inter-textual connections, resulting in improved knowledge development at posttest. Results, however, did not indicate a significant effect for knowledge at posttest.

There are several plausible explanations for this finding. First, the prompts were likely not enough to facilitate enhanced knowledge development for the treatment conditions. Learners likely needed additional instruction to demonstrate differences in knowledge. For example, a short-response prompt that targeted the goal setting and planning phase was "Knowing that your task is focused on making connections across texts, what strategies will you implement to meet your goals?" for the MP+I condition and "What strategies will you implement to meet your goals?" for the MP condition. If learners do not possess adequate knowledge about effective strategies for multiple-text learning, then they likely plan to use ineffective or inappropriate strategies. Applying ineffective or inappropriate strategies will not facilitate knowledge development. This could have been the case in the current study.

Second, participants' beliefs about the learning styles myth likely interfered with knowledge development. Research shows not only that the learning styles myth is extremely pervasive (e.g., Pashler et al., 2008; Riener & Willingham, 2010), but also that undergraduates' beliefs are very strong about the myth (e.g., Young et al., 2022a; Young et al., 2022b). As a result, two refutation texts were likely not enough to support knowledge development given participants' beliefs. It is possible that learners also experienced tension between their beliefs and the two texts. If learners perceived value in identifying with a style and had prior experiences where their beliefs were reinforced (e.g., by teachers), then it makes sense why they would resist changing their beliefs.

Relatedly, the texts' difficulty could have impacted knowledge development. Although findings from the follow-up exploratory analyses indicated knowledge gains at the condition level, mean knowledge scores at posttest were still low. Since participants in this study were mostly first- or second-year undergraduates, they likely did not possess much prior experience with reading college-level texts. Furthermore, they might not have had enough prior knowledge about the topic to engage with the texts as effectively.

Metacognition

The second research question asked whether participants' metacognition, as measured with the shortened MAI and confidence judgments, would differ based upon prompting condition. I hypothesized that after controlling for demographic variables and prior knowledge and metacognition, the treatment conditions would explain a significant amount of variance on the shortened MAI and both metacognitive monitoring indices (i.e., bias and absolute accuracy). Because the treatment conditions explicitly aimed to support learners' metacognition throughout their learning task, I expected to observe differences for the relevant outcomes. Additionally, I hypothesized that the MP+I and MP conditions would be significantly different from one another. The MP+I condition offered more explicit task goal cues, so I expected them to support improved metacognition. Results from the analyses for each outcome, however, did not support my hypotheses; the treatment conditions did not explain a significant amount of variance on the outcomes for metacognition, indicating that the prompting for both treatment conditions was not effective.

I propose several potential explanations for this finding. First, it is possible that there were no effects on the bias and absolute accuracy measures, as the present intervention did not specifically target improving learners' metacognitive monitoring accuracy or calibration. For example, to witness effects on bias and absolute accuracy, it is likely that learners needed instruction, practice, and feedback regarding how to make more calibrated confidence judgments. Second, perhaps the metacognitive prompts were not a strong enough intervention to witness effects on the shortened MAI. It is possible that learners were not aware of why they were engaging in the metacognitive prompts and thus did not make the connection that what they were doing in the study was being metacognitive. With that said, perhaps the current intervention could have implemented transactional strategy instruction (Brown et al., 1995). In transactional strategy instruction, students learn how, why, and when to use a variety of effective strategies in context and gradually assume more responsibility for such strategy use. For example, in this study, I could have taught students how, why, and when to use a select set of SRL and metacognitive strategies in the context of multiple-text learning. A pedagogical agent could have modeled the strategies and scaffolded students' practice using the strategies before allowing learners to implement them independently.

Integration

The third research question addressed whether participants' integration, as measured through their responses to the writing prompt, would differ based upon prompting condition. Given the MP+I condition's explicit language invoking integration task goals, I hypothesized that the treatment conditions would be significantly different from one another. Similarly, since the prompting in both treatment groups targeted learners' SRL and metacognitive monitoring, I expected that the treatment conditions would be significantly different from the control. Results from analyses with the original rubric and collapsed rubric, respectively, did not support the hypothesized outcome, indicating that the prompting was not effective for facilitating improved integration.

There are several explanations for this finding. First, learners likely needed explicit integration instruction in addition to the prompting. Although I hypothesized that the metacognitive prompting would facilitate integration, findings suggest otherwise. Learners could have been aware that their goal was to integrate content across the two texts. However, if they did not know *how* to integrate the information effectively, then being metacognitive likely would not produce an effect. A second potential reason why the metacognitive prompting did not influence learners' integration could be due to the learning task. Across conditions, median and mode integration scores on the original and collapsed rubrics indicated that students generally did not compose integrated writing responses. It could be that the writing prompt was not clear enough for students that the task goal was to produce an integrated response using the two texts.

Third, the texts' difficulty could have prevented learners from integrating effectively. Even if the participants knew how to integrate, it is likely that they would have struggled with demonstrating cross-text connections in their writing due to the length and readability levels of the texts. Relatedly, the texts' content could have prevented integration. Participants likely possessed strong beliefs about learning styles, which would have strongly conflicted with the two refutation texts. Across conditions, median and mode integration scores for both the original and collapsed rubrics also indicated that integration was not common with one exception. For the MP condition, the most common score using the original rubric was a six (i.e., the highest possible score).

Another plausible explanation concerns learners' motivation. It is possible that learners were not motivated to integrate in the current study, because they did not find the task relevant or valuable or were not efficacious enough, for example.

Strategy Use

The fourth and final research question addressed whether learners' strategy use, as measured with the MTSI, would differ based upon prompting condition. Because the prompting in the MP+I condition specifically targeted integration task goals, I hypothesized that the treatment conditions would be significantly different from one another. Such task cues were expected to facilitate the implementation of more appropriate strategies for the task in the MP+I condition. However, since both treatment conditions attempted to support learners' SRL and metacognitive monitoring, I further expected that both treatment conditions would be significantly different from the control. Results were inconsistent with my hypotheses, and findings indicate that the metacognitive prompts offered in this study were not an effective method for supporting improved multiple-text strategy use.

A potential explanation for this finding is that the metacognitive prompting did not facilitate learners' use of effective strategies for multiple-text reading. Despite targeting learners' goal setting and planning, enacting tactics, and monitoring of strategy use, the prompts may have been insufficient, especially if learners were unaware of what strategic behavior looked like in this context. Learners may have needed explicit strategy instruction to know which strategies would be effective to implement for multiple-text learning. As mentioned earlier, perhaps a transactional strategy instruction approach would have been a valuable method for delivering such explicit strategy instruction (Brown et al., 1995).

Limitations

The current study has several important limitations. First, 195 student responses were removed, because they did not complete the posttest. Several explanations for such high levels of attrition are possible. First, given that this study was administered via

Qualtrics, students might have opened the survey and did not finish it upon their first try but completed it upon opening it a second time. Second, it is also possible that many students did not complete the study, because they found it too cumbersome or lengthy given the incentive. Students could have perceived the time commitment to participate in the current study as too costly given the compensation. In addition, the high levels of attrition could be attributed to the texts' difficulty. Given that the texts were likely challenging for the participants, it is possible that students did not complete the study because of the learning task. Last, it is also possible that many students withdrew from the study because the content contradicted their beliefs. Given that research shows undergraduates have strong beliefs about the learning styles myth (e.g., Young et al., 2022a; Young et al., 2022b), learners in this study likely also had strong beliefs. Since the texts in the current study refuted the myth, participants could have experienced negative emotions, prompting them to discontinue their participation.

Regardless of the cause, the number of responses that had to be removed warrants attention. In future studies, care will be devoted to ensuring participants are aware of the time commitment to participate and providing suggestions for optimal times to participate (e.g., sharing with students that blocking off time to participate in a quiet space would be an effective strategy). In addition, I will increase the incentive given the time commitment needed for students to participate. Furthermore, in future studies, texts that are more appropriate for the participants and study design will be used. Limitations regarding the texts' difficulty and content are discussed in greater detail below.

A second limitation concerns the characteristics of the sample. In this study, participants were mostly white undergraduate females from a large research institution.

Most participants were also in their first or second year of a program in the College of Education. The lack of diversity in the sample seriously limits the ability to generalize findings to learners from other background and institutions, for example. Future work should attend to the importance of examining the intervention with different groups and more diverse samples to learn more about how students from other racial, ethnic, and gender identities, for instance, experience the metacognitive prompting intervention.

Third, given the scope of this study, it was not possible to analyze all data collected, such as learners' responses to the prompts in the treatment conditions. These data could help paint a more comprehensive picture regarding the metacognitive prompting intervention's effects. Future work will follow up by exploring these data in several ways. First, I will code learners' responses to examine how well they understood the prompts. Overall findings suggest that the prompts were not effective, but a more detailed prompt-level analysis will allow us to examine which prompts seemed effective and which could benefit from improvement. Second, I will explore students' responses to examine how well they defined the given task, what strategies they planned to execute, how the texts related to what they knew, and what they would do similarly/differently in future tasks. This information will be valuable in several ways. For example, knowing how learners defined the learning task I designed could illuminate whether the task instructions needed to be more explicit. Third, I will use students' responses to the prompts as a measure of SRL. One critique of SRL research is that it relies heavily on self-report measures, although other fields of study receive this critique as well. Given that this intervention was grounded in Winne and Hadwin's (1998) model of SRL model and structured throughout learning, I have unique data that could elucidate how prompted SRL unfolds in a multiple-text learning task.

A fourth limitation concerns the knowledge measure in this study. Although the measure's development was guided by conventions in the existing literature, it is possible that the knowledge instrument at posttest assessed learners' reading comprehension through the declarative and conceptual items. Similarly, it is also possible that the instrument instead assessed participants' beliefs about learning styles. The implications of learners' beliefs are discussed in greater detail below, but they are important to consider in the context of measurement issues regarding the knowledge instrument.

Last, the texts in this study presented several challenges for the current study. Regarding the texts' content, despite being refutation texts, learners' beliefs were likely very strong about the learning styles myth, given the pervasiveness of this myth (Kirschner & van Merriënboer, 2013; Pashler et al., 2008; Riener & Willingham, 2010; Young et al., 2022a; Young et al., 2022b). Participants likely experienced tension in the study if this was their first encounter with learning styles being presented as a myth. As a result, participants could have been confused about how to engage with the study. For example, in the knowledge measure, participants could have been conflicted about which option to select, the one that endorsed their beliefs and inaccurate knowledge or the one that aligned with what they learned from the texts.

Thus, a brief intervention was likely not enough to observe effects on the outcomes of interest, especially since the intervention did not target belief change. Research in conceptual change, or learning that alters a preexisting notion, has demonstrated that changing learners' beliefs or misconceptions is difficult (e.g., Chi et al., 1994). Despite this challenge, researchers have examined interventions to promote conceptual change. For example, Heddy and Sinatra (2013) examined the Teaching for Transformative Experiences in Science (TTES) model against a comparison group that received refutation texts and engaged in discussion. Heddy and Sinatra studied undergraduate students' learning about biological evolution. They found that the TTES condition demonstrated greater conceptual change compared to the refutation and discussion condition, among other findings. Thus, research in conceptual change suggests that refutation texts alone may not be strong enough to produce effects in belief change compared to other intervention strategies.

Furthermore, given the texts' length and readability levels, they were likely very challenging for the participants. This is particularly important to consider for those first-year students, who were in their first semester of college when they participated in this study. The study design employed was predicated on the assumption that learners would be able to successfully engage with the two texts. However, if the texts were too challenging, then the participants likely either spent most of their cognitive energy processing the texts or decided that reading the texts was too costly. Thus, it is possible that participants were not prepared or motivated to engage with the texts.

Future Directions

Despite the null findings and limitations, the current study offers several rich future directions for research. I propose five main avenues: expanding the intervention, testing the intervention with different texts, studying the intervention with different groups of students, examining the role of all SRL variables, and exploring different types of texts in multiple-text learning.

First, this study made important progress in developing an intervention grounded in SRL to support multiple-text learning. To address the findings from the current study, future work could expand the intervention is several ways. For example, two enhanced instructional components include addressing what, why, when, and how (Veenman et al., 2006) of metacognition and supporting metacognitive monitoring accuracy. These additions could support learners' enhanced outcomes in metacognition. Furthermore, future work could augment the metacognitive prompting tested in the current study by including integration strategy instruction. By explicitly providing effective strategies to support multiple-text learning, this addition could not only support learners' strategy use, but also their knowledge development and integration. Providing strategies that facilitate intra- and inter-textual connections could be an effective method to observe positive effects on these outcomes. Overall, the combined effects of strategy instruction and metacognitive prompting may demonstrate significant effects on multiple-text and SRL outcomes. By expanding the intervention in these ways, the dosage and duration would likely need to be enhanced as well.

Second, I propose that future research examines the current intervention with different texts. In the current study, learners engaged with refutation texts about the learning styles myth. However, given the pervasiveness of the myth and learners' potentially strong beliefs, I recommend that future research explores how the intervention functions when learners engage with expository texts about a different topic. Perhaps learning from documents that do not refute a widespread misconception would produce different effects on the outcome of interest. In addition, given the texts' difficulty, I propose that future research examines the intervention with expository texts that are more appropriate for the study participants. It is likely that texts of a more appropriate length and readability level for the participants would increase the potential for examining the true effects of the intervention.

Third, I believe that future research could explore the intervention with different groups of students. Much like the extant research, I examined how undergraduate students learned from multiple texts in the current intervention. However, less is known about promoting younger learners' engagement with multiple texts through interventions. Thus, future work could study how the metacognitive prompting intervention could be adapted to benefit middle school students, for example. Perhaps supporting middle school students' SRL and multiple-text learning would be more beneficial to promote enhanced outcomes earlier.

Fourth, although the current study made important progress in examining SRL outcomes in the context of multiple-text learning, motivation was not examined. Motivation is typically understudied as an outcome in previous multiple-text interventions as well. Future research could examine the effects on motivational outcomes, such as self-efficacy or achievement goals, which would not only elucidate intervention effects but also provide important additional insight into learners' motivation for such tasks. For example, little is currently known about learners' self-efficacy for completing multiple-text tasks.

Last, in line with prior research in multiple-texts and multiple-text interventions, the current study provided learners with two informational, refutation texts. Although examining learning from expository texts is critical, investigating how learning occurs from other types of texts is equally important. For example, learning from multiple texts in the context of English Language Arts (ELA) instruction has not received as much attention within the multiple-text literature. In ELA contexts, students often learn from and integrate information across informational texts, literary texts, and media. Future work could examine how existing interventions that have strong empirical support function in such text-based scenarios and develop interventions to support the unique products, such as literary critiques or thematic analyses.

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Appendix A

Knowledge Measure

D=Declarative item
C=Conceptual item
Bolded text=Correct response
*Item removed from analyses

1. The premise of learning styles is that (D)
    a. **learning improves when instruction and students' learning styles align.**
    b. learning improves when objectives, assessment, and activities align.
    c. students need teachers' help identifying their preferred learning style.
    d. students' learning styles do not predict their learning outcomes.
2. Teaching to students' learning styles (D)
    a. does not result in deep learning.
    b. improves learning outcomes.
    c. **is not supported by research.**
    d. makes learning easier for students.
3. Ash believes they are a visual learner. According to Ash, they will learn the most by (C)
    a. listening to a podcast about a novel.
    b. reading a novel from a tangible book.
    c. **watching a film adaptation of a novel.**
    d. performing scenes from a novel.
4. Which of the following is true of teachers? (D)
    a. They should make instructional decisions based on students' learning styles.
    b. They should assume information presented in their courses and exams is always accurate.
    c. They should attend professional development workshops about learning styles.
    d. **They should make instructional decisions based on students' prior knowledge.**
5. In the education community, (D)
    a. **learning styles theories are still a pervasive idea and pedagogical priority.**
    b. there is disagreement among teachers about the effects of learning styles.
    c. there is agreement among teachers that learning styles are a myth.
    d. learning styles theories have been debunked and replaced with better pedagogies.

6. Mr. Wright teaches Algebra II. He is preparing for the new school year and wants to meet his students' needs. Mr. Wright should (C)
    a. start the school year with a cumulative exam.
    b. **assess his students' mathematical knowledge.**
    c. assume his students' background knowledge.
    d. survey his students for their learning styles.
7. Most of what students learn is (C)
    a. visually based.
    b. **meaning based.**
    c. auditorially based.
    d. kinesthetically based.
8. In the brain, auditory, motor, and visual input processing (C)
    a. occurs separately.
    b. occurs sometimes.
    c. **is interconnected.**
    d. is not efficient.
9. There is no evidence that (D)
    a. workshops and professional development about learning styles exist for teachers.
    b. people have preferences for how they like to process information.
    c. **learning improves when instruction is provided in a preferred learning style.**
    d. researchers, teachers, and organizations disagree about learning styles.
10. One criticism of teacher licensure exams is they (D)
    a. assess aspiring teachers' critical consumption of research.
    b. **do not accurately reflect evidence-informed practice.**
    c. do not assess aspiring teachers' learning styles knowledge.
    d. accurately represent what research shows about learning styles.
11. Which of the following is a poor predictor of students' learning? (C)
    a. Ability
    b. Interest
    c. **Learning style**
    d. Prior knowledge
12. Studies supporting learning styles (D)
    a. are mostly empirical.
    b. show reliability.
    c. **lack validity**.
    d. are statistically significant.
13. *Often, textbooks for aspiring teachers (D)
    a. provide clear refutations of learning styles theories.
    b. **include information about learning-styles-based instruction.**
    c. cite research studies that do not support learning styles theories.
    d. explain why accommodating learning styles is ineffective.

14. Mia tells her teacher that she doesn't understand the novel she's reading. Since Mia thinks she's an auditory learner, she tells her teacher she needs to listen to the novel instead. Mia's teacher should (C)
    a. read the novel aloud to Mia after school.
    b. provide Mia with an audio recording of the novel.
    c. suggest that Mia try walking while reading the novel.
    d. **teach Mia strategies that support comprehension.**
15. Many people believe in learning styles because they are (D)
    a. **seen as common knowledge.**
    b. recommended by experts.
    c. supported by valid evidence.
    d. backed by reliable evidence.
16. Regarding learning styles, teacher licensure exams (D)
    a. fail to assess them.
    b. **include content about them.**
    c. require critique of them.
    d. question their validity.
17. Which of the following is true? (D)
    a. Learning disabilities affect students' different learning styles.
    b. **Learning disabilities affect students' learning in specific ways.**
    c. Students with autism learn best through kinesthetic learning styles.
    d. Students with dyslexia learn best through auditory learning styles.
18. Antón is preparing for his Praxis licensure test by using public preparation materials. Which of the following best describes a potential exercise Antón might encounter? (C)
    a. Describe why teaching to students' learning styles does not support learning.
    b. Present an argument weighing the pros and cons of teaching to learning styles.
    c. **Create a lesson showing instructional alignment with learning styles assessments.**
    d. Explain why prior knowledge is a better predictor of learning than learning style.
19. Dedicating time and energy to teaching to students' learning styles (D)
    a. is a strategic use of teachers' time.
    b. is not widely accepted by teachers.
    c. **will not produce learning outcomes.**
    d. will cause students to succeed academically.

Appendix B

Integration Essay Prompt

One of your classmates heard that learning styles aren't real but doesn't know much background information. They're skeptical, because many of their teachers talked about learning styles and the idea always seemed to make sense to them. Using what you learned from the two sources, compose an explanation you could offer to your classmate. Think about what your classmate would need to know about the myth, why it's so pervasive, and the implications of students and teachers believing in the myth. Be sure to include and cite the two sources in your response.

Appendix C

Original Integration Rubric

Score	Description
0	No response or irrelevant response
1	Provided a response that was tangentially relevant
2	Provided a response that was clearly relevant but lacked textual support
3	Used content from one text or explicitly referenced one text in response
4	Used content from more than one text without integration
5	Integrated content from both texts without reference to the specific texts in response
6	Integrated content from both texts with reference to the specific texts in response

Appendix D

Collapsed Integration Rubric

Score	Description
0	No response or irrelevant response, provided a response that was tangentially relevant, or provided a response that was clearly relevant but lacked textual support
1	Used content from one text, explicitly referenced one text in response, or used content from more than one text without integration
2	Integrated content from both texts with or without reference to the specific texts in response