THE IMPLICIT AND THE EXPLICIT:

THE IMPACT OF TEACHING ACADEMIC MINDSETS AND READING STRATEGIES ON BEGINNING COLLEGE LEARNERS' READING COMPREHENSION

by

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A dissertation submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Education

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DEDICATION

I dedicate this dissertation to Phyllis, my mother.

Strength and dignity are her clothing,
and she laughs at the time to come.
She opens her mouth with wisdom,
and the teaching of kindness is on her tongue.
She looks well to the ways of her household
and does not eat the bread of idleness.
Her children rise up and call her blessed;
her husband also, and he praises her:
"Many women have done excellently,
but you surpass them all."
Charm is deceitful, and beauty is vain,
but a woman who fears the Lord is to be praised.
Give her of the fruit of her hands,
and let her works praise her in the gates.
Proverbs 31:25-31 ESV

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LIST OF KEY TERMS

Academic mindset	A set of implicit beliefs about intellectual or academic abilities (Dweck, 1999, 2006).
Fixed mindset	A fixed mindset, also referred to as an entity theory of intelligence, is an implicit belief that intelligence is static, dictated by DNA, and cannot be changed by one's efforts (Dweck, 1999, 2006).
Growth mindset	A growth mindset, also referred to as an incremental theory of intelligence, is an implicit belief that intelligence is malleable and that it can be improved over time by coupling effort with strategic knowledge (Dweck, 1999, 2006).
Achievement goals	Achievement goals are a set of underlying thoughts about the desired benefits and potential consequences of pursuing competence that direct academic behaviors (Kaplan, Middleton, Urdan, & Midgley, 2002; Vrugt & Oort, 2008).
Mastery goals	Mastery goals are a set of underlying thoughts about the purposes of engaging in academic tasks that focus on learning as much as possible, developing new skills, and improving oneself (Dweck, 1999, 2006; Dweck & Leggett, 1988; Stipek & Gralinski, 1996).

Mastery-approach goals Mastery-approach goals are a set of underlying thoughts about the purposes of engaging in academic tasks that focuses on the desire to successfully learn as much as possible, develop new skills, and improve oneself (Elliot & Thrash, 2001; Kaplan & Maehr, 2007).

Mastery-avoidance goals Mastery-avoidance goals are a set of underlying thoughts about the purposes of engaging in academic tasks that focus on the undesired possibility of not learning as much as possible, not developing new skills, and not improving oneself over time (Elliot & Thrash, 2001; Kaplan & Maehr, 2007).

Performance goals Performance goals are a set of underlying thoughts about the purposes of engaging in academic tasks that focus on achieving normative levels of competence (Dweck, 1999, 2006; Dweck & Leggett, 1988; Stipek & Gralinski, 1996).

Performance-approach goals Performance-approach goals are a set of underlying thoughts about the purposes of engaging in academic tasks that focus on the potential of successfully achieving or surpassing normative levels of competence (Elliot & McGregor, 2001).

Performance-avoidance goals	Performance-avoidance goals are a set of underlying thoughts about the purposes of engaging in academic tasks that focus on the undesired possibility of failing to achieve normative levels of competence (Elliot & McGregor, 2001).
Reading efficacy	For the purposes of this research, reading efficacy is defined as learners' judgments of their ability to succeed at comprehending academic texts (Anmarkrud & Bråten, 2009).
Reading Comprehension	Reading comprehension is a qualitative feature of readers' ability to learn from texts by integrating what is being read with their prior knowledge so they can construct a cohesive mental representation of the ideas and concepts presented in the text (Kendeou, van den Broek, Helder, & Karlsson, 2014; Kintsch, 1988).
Text representation - surface-code	Text comprehension is minimal. Self-explanations of the text are expressed by exact representations of the text as it is written (Graesser, Millis, & Zwaan, 1997; Magliano et al., 1999).

Text representation - textbase	Text comprehension is limited. Self-explanations of the text are expressed by the readers' own language to represent the original text (Haenggi & Perfetti, 1994; Kintsch, 1994).
Text representation - situation/mental model	Text comprehension is advanced. Self-explanations of the text are expressed by complex and detailed mental representations of text by connecting or bridging text segments that are separated by distance within the text (global cohesion), as well as by elaborating or making connections to information beyond the immediate text (Kintsch, 1994; Oakhill et al., 2003).

ABSTRACT

The transition to college may present beginning college learners with novel academic opportunities and challenges, including the requirement to learn independently from complex college-level texts. Several achievement motivation factors may play a role in explaining differences in beginning college learners' use of deep-level reading comprehension strategies to comprehend complex college-level texts. This study examined Dweck's (1999) theoretical model of implicit beliefs about intelligence by employing an experimental design to examine whether teaching a growth mindset to beginning college learners prior to providing explicit reading comprehension strategy instruction impacted beliefs about their own intelligence, motivational beliefs, reading comprehension strategy use, and reading comprehension. Prior research indicates that maintaining a growth mindset about intelligence contributes to higher self-efficacy beliefs and mastery-approach oriented achievement goals, which are believed to positively influence strategic processes. Prior research also suggests that self-efficacy beliefs and mastery-approach goals may have a positive impact on achievement outcomes through the mediation of deep-level strategic processes. The results of this study are not consistent with Dweck's (1999) theoretical model. Mastery-approach goals had a suppression effect on the direct relationship between learners' incremental beliefs and use of reading comprehension strategies. Also, in comparison to the control group, learners in the growth-mindset treatment group did not experience the anticipated positive changes in their pattern of achievement goal adoption, strategy use, or reading comprehension. The results showed that the patterns of motivational beliefs and achievement outcomes were in the opposite direction of the

predictions. The findings of this research indicate that there is variability in the ways that intelligence and motivational beliefs interact to impact strategic behaviors and learner outcomes. In addition, the findings highlight the need for examining the influential role of learners' experiences within learning environments at both the course and institutional level. Limitations of the study, including the significant loss of power for inferential tests, are also discussed.

Chapter 1

INTRODUCTION

Undergraduate college enrollment has dramatically increased in the United States over the last 25 years. According to the National Center for Education Statistics (NCES; 2013b), college enrollment increased from approximately 12.5 million to 14.3 million students (13.7%) between 1992 and 2002. In the following decade, between 2002 and 2012, undergraduate college enrollment increased an additional 24.3% from 14.3 million to 17.7 million students. On the surface, these statistics are quite impressive and indicative of America's desire to improve the educational status of all youth so that they are positioned to compete in 21st-century global markets. Indeed, President Barack Obama's (2014) White House position underscores the significance of these accomplishments: "Earning a post-secondary degree or credential is no longer just a pathway to opportunity for a talented few; rather, it is a prerequisite for the growing jobs of the new economy" (para. 1).

Problem Statement

Hidden within these numbers, however, are two sobering realities. First, while undergraduate enrollment has steadily increased, so, too, has the number of students within each cohort who are not sufficiently prepared for higher education (Greene & Forster, 2003). For many learners, there is a gap between what it takes to successfully complete high school and what it takes to experience a successful transition to academic life in college. Some who may have been high performers in the past find that the academic strategies they used in high school result in far fewer successes in college (Balduf, 2009). Over the last decade, colleges and universities reported that almost one-third of entering freshmen at moderately selective postsecondary institutions and 60% of entering freshmen at non-selective postsecondary institutions are underprepared in reading, math, or writing (Bettinger, Boatman, & Long, 2013; National Center for Public Policy and Higher Education & Southern Regional Education Board, 2010; Parsad & Lewis, 2003).

According to the National Center for Public Policy and Higher Education and Southern Regional Education Board (2010),

> While access to college remains a major challenge, states have been much more successful in getting students into college than in providing them with the knowledge and skills needed to complete certificates or degrees. […] Even those students who have done everything they were told to do to prepare for college find, often after they arrive, that their new institution has deemed them unprepared. Their high school diploma, college-preparatory curriculum, and high school exit examination scores did not ensure college readiness. (p. 1)

The lack of sufficient academic skills and knowledge to successfully transition from secondary school-level tasks to the rigorous demands of college-level coursework is likely to have a negative impact on beginning college learners' academic performance (Balduf, 2009; McCabe, 2000). Furthermore, insufficient preparation for college-level academic tasks among beginning college learners is believed to be one explanation for the persistence of stagnantly low national college completion rates, despite increasing levels of undergraduate college enrollment (Greene & Forster, 2003; Symonds, Schwartz,

& Ferguson, 2011). According to *The National Condition of Education* (NCES, 2014c), the six-year graduation rate for first-time, full-time students who began college in fall 2006 at four-year degree-granting institutions was 59%. At two-year degree-granting institutions, the respective three-year graduation rate was only 31%. Under-preparation for college-level work may be an underlying reason because learners who lack sufficient academic skills for college face greater difficulty in completing course requirements than their peers who have sufficient academic skills (Au, 2000). As a result, learners with insufficient academic skills and knowledge may experience poor course performance and fail to earn sufficient credits toward the completion of their credential within the timeframes specified by their institutions (Cox, Friesner, & Khayum, 2003).

Purpose and Significance of the Study

One way to improve beginning college learners' performance as they transition to college is to improve the core academic skills they will need to be successful in college. Sufficient academic preparation for college involves more than amassing foundational content knowledge from select subjects in high school. Learners must also procure and master academic skills and knowledge that they can apply across academic disciplines (Conley, 2007; Roderick, Nagaoka, & Coca, 2009). The acquisition and proficient use of core academic skills and knowledge such as reading comprehension, writing, notetaking, summarizing, test preparation, studying, communicating with teachers, and time management has long been tied to positive course outcomes and overall academic success in college (Crede & Kuncel, 2008; Elliot, McGregor, & Gable, 1999; Zimmerman & Kitsantis, 2005).

The present study focuses on one core academic skill required for success in most, if not all, college majors and courses. Comprehension of complex texts is widely regarded as one of the most critical competencies necessary for student achievement across all academic disciplines (American College Testing [ACT], 2006; Alliance for Excellent Education [AEE], 2002; Conley, Drummond, de Gonzalez, Rooseboom, & Stout, 2011; Heller & Greenleaf, 2007). When an adult reader possesses proficient comprehension skills, he or she can

> read a variety of materials with ease and interest, can read for varying purposes, and can read with comprehension even when the material is neither easy to understand nor intrinsically interesting. […Proficient readers] are capable of acquiring new knowledge and understanding new concepts, are capable of applying textual information appropriately, and are capable of being engaged in the reading process and reflecting on what is being read. (Snow, 2002, p. xiii)

Understandably, proficient comprehension skills are necessary in college courses and are related to learners' academic performance because an extensive amount of college students' learning is derived from reading complex course materials and texts (Roberts, Suderman, Suderman, & Semb, 1990). An inability to comprehend complex challenging texts can hinder and potentially abort students' academic progress in college (Au, 2000).

Focusing on beginning college learners' reading comprehension proficiency is significant because many high-school students graduate without acquiring the necessary skills to comprehend college-level texts. In 2005, only 35% of twelfth-grade students scored at or above the level of proficiency in reading by demonstrating competence for reading challenging texts (Grigg, Donahue, & Dion, 2007). In 2009 and 2013, respectively, 37% and 36% of twelfth-grade students who took the National Assessment of Educational Progress Reading Assessments scored at or above the level of proficiency (NCES, 2014a). While all high-school graduates do not pursue postsecondary learning opportunities, historically about two-thirds enroll in either two-year or four-year degree programs (NCES, 2013a). Consequently, if we assume "all" proficient twelfth-grade readers elect to attend college after graduation, a conservative estimate is that one-third of beginning college learners may be challenged to comprehend college-level texts because of their complexity.

In response to the academic (and social) transition challenges faced by a large number of beginning college learners, many two- and four-year degree-granting institutions offer first-year college experiences to help learners successfully adjust to college life and the rigorous demands of college-level work (Inkelas, Daver, Vogt, & Leonard, 2007; Porter & Swing, 2006; Zhao & Kuh, 2004). Although they may differ in design, first-year college experiences typically share the common goal of equipping first-year students with the skills and knowledge necessary to successfully direct and manage their time in college (Sparks & Malkus, 2013). The present study focused on beginning college learners enrolled in a required first-year college experience course in a two-year Associate in Arts (AA) program. The first-year course is a small class discussion course that introduces strategies for academic success and includes access to an automated explicit reading strategy instruction program.

Despite the offering of first-year courses and other college adjustment supports, such as reading strategy instruction, some beginning college learners still struggle with the academic demands of college, including comprehension of complex texts. These difficulties may result in poor academic performance during their first year of college (Lotkowski, Robbins, & Noeth, 2004). For many, the necessity of transitioning from a reliance on surface-level comprehension strategies that promote memorization and basic understanding of texts to using deep-level comprehension strategies that support analytical and critical thinking, synthesis, and the construction of new meaning, is not easily realized (Simpson & Nist, 2000). While former comprehension strategies may have been sufficient in high school, college-level reading requires more.

Beginning college learners who believe that a high-school degree signifies adequate academic preparation for college-level work (as opposed to successful completion of high school) may be caught off-guard when they experience academic impediments, such as struggling to comprehend challenging texts. Furthermore, new college learners may be bewildered when they discover that many college-level tasks require a more substantial commitment of time and effort to identify and develop strategic reading processes aimed at independent learning, compared to what was required of them in high school. Although some novice college learners will rise above these challenges, others may become discouraged if they experience multiple failures as they struggle to comprehend complex texts; some even give up. One factor that may affect learners' responses to the increased and varied demands of college-level reading comprehension is their beliefs about their own intellectual or academic abilities. These beliefs are also known as academic mindsets (Dweck, 2006).

Dweck (1999; 2006) describes two commonly held academic mindsets about intelligence that influence the way learners respond to challenges. When struggling to comprehend college-level texts, beginning college learners who believe they can learn any skill with sufficient resources, time and effort to improve their abilities (growth-mindset or incremental theorist) are much more resilient than those who believe their ability to learn is limited by innate characteristics (fixed-mindset or entity theorist) (Yeager, Paunesku, Walton, & Dweck, 2013). Consequently, learners maintaining growth-mindset beliefs may be motivated to contribute greater effort and time to work on challenging reading tasks, which may enable them to try out and learn new reading strategies. Conversely, learners with fixed-mindset beliefs may experience inertia (a cessation of effort) because they believe their struggle to comprehend complex texts is due to their intellectual limitations. They doubt that increasing their efforts or trying out new strategies will result in successful task completion (Dweck, 1999; Silva & White, 2013). The first purpose of this study was to examine whether growth mindsets (versus fixed mindsets) are related to beginning college learners' reading comprehension strategy use and achievement outcomes and whether this relation is mediated through learners' motivational beliefs.

Research on implicit theories of intelligence also indicates that intelligence beliefs play an important role in orienting learners' motivation for achievement, particularly their thoughts about the desired benefits and potential consequences of undertaking challenging tasks, including the comprehension of complex texts (Dinger & Dickhauser, 2013; Doron Stephan, Boiché, & Le Scanff, 2009; Dupreyrat & Mariné, 2005; Sevincer, Kluge, & Oettingen, 2014). Specifically, learners who hold a growth mindset are more likely to define and pursue competence in terms of acquiring task proficiency, skill development, or self-improvement (mastery goals). In contrast, learners who hold a fixed mindset are more likely to define and pursue levels of competence to substantiate that they possess sufficient skill and ability relative to their peers (performance goals) (Dweck, 1999, 2006; Yeager & Dweck, 2012). Recent research shows that college learners who maintain growth-mindset beliefs or reject fixed-mindset beliefs are more likely to endorse mastery-oriented goals, employ deep-processing strategies for studying and learning, and persist during academic challenges (Braasch., Braten, Stromso, & Anmarkrud, 2014; Dinger & Dickhauser, 2013; Dupreyrat & Mariné, 2005; Robbins & Pals, 2002).

Contemporary research on achievement motivation has further distinguished mastery and performance goals by approach and avoidance subtypes. These subtypes differentiate whether learners are motivated to pursue opportunities to achieve (approach) or avoid experiencing the inability to achieve their competency goals (Elliot, 1999; Elliot & Thrash, 2001). The two subtypes of performance goals differentiate whether learners' competency goals reflect a desire to avoid coming up short relative to their peers (performance-avoidance) or a desire to attain norm-referenced competence (performance-approach) (Elliot, 1999; Elliot & Thrash, 2001). Although some research has examined the relation between performance-approach and -avoidance goals and beliefs about intelligence, little attention has been given to distinguishing between mastery-approach and -avoidance goals. Most of the literature has focused on mastery goals in general, which typically are synonymous with mastery-approach goals (Wirthwein, Sparfeldt, Pinquart, Wegerer, & Steinmayr, 2013). This study is unique in that it examined mastery-avoidance goals.

The literature on mastery-avoidance goals, the desire to avoid experiencing the inability to achieve task proficiency or to retain, improve, or develop one's skills, is sparse. Emerging evidence from studies that have focused on the distinction between both subtypes of mastery goals, however, suggests that incremental beliefs about intelligence have more of a positive influence on learners maintaining mastery-approach goals than mastery-avoidance goals (Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2013). The present research extended Dweck's (1999) model by employing the 2x2 achievement goal conceptualization to distinguish mastery-approach and -avoidance goals. Mastery-avoidance goals are germane to this research because some beginning college learners who did well in high school may experience novel levels of difficulty attaining task mastery when academic rigor increases, especially if they are not sufficiently prepared for college. For these mastery-avoidance oriented learners, difficulty comprehending complex texts may lead them to develop an overreliance on surface-level strategies they found helpful in the past (i.e., rote memorization and paraphrasing) to minimize the potential for making comprehension mistakes and to successfully complete reading tasks, albeit without understanding texts in their entirety (Elliot & Thrash, 2001).

In addition to achievement goals, self-efficacy beliefs were explored in the present research because they also appear to play a pivotal mediating role in explaining the relations between intelligence beliefs and achievement outcomes (Wood & Bandura, 1989). In general, efficacy beliefs reflect learners' confidence about whether they can successfully achieve particular goals (Schunk & Pajares, 2005). When learners' efficacy beliefs are high, they are inspired to take risks because their prospects are positive. When learners have low efficacy beliefs, they are likely to ponder whether they should bother to exercise effortful engagement on a task if they believe they are most likely going to fail (Bandura, 1978, 1986; Schunk, 1991). An important feature of self-efficacy beliefs is that they are domain-specific (Pajares, 1996). Consequently, the present research focused on reading efficacy for academic texts.

Although few studies were found that examined implicit beliefs about intelligence and reading efficacy, there is evidence from another self-efficacy domain (i.e., organizational management, discussed below) that when challenging tasks arise, low efficacy beliefs may be particularly consequential for college learners maintaining fixed-mindset beliefs (Wood & Bandura, 1989). When learners with fixed mindsets believe they lack requisite skills, their status as being "smart" for having earned a high-school diploma no longer provides validation for who they are as college students. Simply put, they no longer see themselves as "competent." Instead, they may believe they are "intellectually deficient" for success in college, and thus develop doubts about their ability to complete college-level academic tasks (Dweck, 2006). As a result, learners who hold fixed mindsets and low efficacy beliefs may adopt helplessness behaviors, such as disengaging from effortful strategic processes (Dweck, 1986; Wood & Bandura, 1989). Unless interrupted, this cycle may lead affected learners into a downward academic spiral.

The present research was built on this question: "Is there a way to prevent the downward academic spiral of beginning college learners who have low comprehension skills and maintain beliefs that support the notion that intelligence is fixed?" Prior research has shown that college learners' academic mindsets can be manipulated through brief social-psychological interventions that can have consequential impacts on learners' subsequent self-efficacy beliefs, strategic academic behaviors, and achievement (Aronson, Fried, & Good, 2002; Hong, Chiu, Dweck, Lin, & Wan, 1999; Wood & Bandura, 1989; Yeager & Walton, 2011). Although few, if any, studies have examined the impact of manipulating learners' academic mindsets on reading comprehension strategy use, the findings of prior research are promising. Accordingly, the second purpose of this study was to ascertain if teaching a growth mindset of intelligence supports the adoption of beneficial intelligence and motivational beliefs, increased use of deep-level reading comprehension strategies, and higher academic performance among learners.

Research Design

To induce incremental beliefs, half of learners in this study were randomly introduced to the growth mindset by way of a short video and a compelling scientific article about research findings that showed intelligence is malleable and can be improved by effort and appropriate strategy use. The compelling materials were described as “derived from the latest scientific research.” This intervention was intended to manipulate mindsets so that learners endorse higher incremental beliefs about intelligence, higher mastery-approach oriented competency goals, and higher self-efficacy for learning beliefs than they had held prior to the intervention. After the intervention, learners received reading comprehension strategy instruction by way of an automated tutor. The goal was for learners who participated in the growth-mindset intervention to use significantly more of the reading comprehension strategies they had been taught, particularly the deep-level reading strategies, than learners in the control group. Furthermore, it was expected that learners in the growth-mindset treatment condition would demonstrate higher achievement outcomes than learners in the control group.

In summary, several achievement motivation factors may play a role in explaining differences in beginning college learners’ strategic behaviors in response to impediments to learning and repeated failures, such as those that may occur when students struggle to comprehend complex college-level texts. Learners’ reading comprehension of complex texts may improve as they increase their use of deep-level reading comprehension strategies. This study is unique in that it sought to examine the influence of beginning college learners’ intelligence beliefs on their reading comprehension strategy use and achievement outcomes. Learners’ intelligence beliefs influence two motivational factors that are commonly assessed in achievement motivation research with regard to strategic processes, specifically self-efficacy beliefs (Cantrell, Correll, Clouse, Creech, Bridges, & Owens, 2013; Robbins, Lauver, Le, Davis, Langley, & Carlstrom, 2004; Torres & Solberg, 2001; Zimmerman & Kitsantis, 2007) and achievement goals (Bernacki, Byrnes,

& Cromley, 2012; Harackiewicz, Barron, Tauer, & Elliot, 2002; Kolic-Vehovec, Roncevic, & Bajsanski, 2008; Muis, Ranellucci, Franco, & Crippen, 2013). Furthermore, inducing a growth mindset may foster adaptive motivational goals and beliefs that encourage the use of deep-level comprehension processing and improve achievement outcomes (Aronson et al., 2002; Hong et al., 1999; Paunesku, Walton, Romero, Smith, Yeager, & Dweck, 2015; Wood & Bandura, 1989). This study attempts to shed light on how colleges can address motivational and cognitive processes that influence beginning college learners, especially those who are underprepared for the rigorous demands of college.

Research Questions and Hypotheses

This research explored the following three research questions:

1. Do motivational beliefs mediate the relationship between implicit theories of intelligence and reading comprehension strategy use?
2. Does reading comprehension strategy use mediate the relationship between motivational beliefs and achievement outcomes?
3. Does a growth-mindset intervention influence learners' endorsement of implicit intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes?

Based on prior research pertaining to the constructionist model of reading comprehension and the social cognitive theory framework, the following hypotheses were predicted for the first research question:

1. Mastery-approach goals mediate the positive relationship between incremental beliefs about intelligence and reading comprehension strategy use.

2. Mastery-avoidance goals mediate the positive relationship between incremental beliefs about intelligence and reading comprehension strategy use.
3. Performance-avoidance goals mediate the negative relationship between entity beliefs about intelligence and reading comprehension strategy use.
4. Performance-approach goals mediate the negative relationship between entity beliefs about intelligence and reading comprehension strategy use.
5. Reading efficacy beliefs mediate the positive relationship between incremental beliefs about intelligence and reading comprehension strategy use.

With respect to the second research question, the following hypotheses were predicted:

1. Reading comprehension strategy use mediates the positive relationship between mastery-approach goals and academic outcomes.
2. Reading comprehension strategy use mediates the negative relationship between mastery-avoidance goals and academic outcomes.
3. Reading comprehension strategy use mediates the positive relationship between performance-approach goals and academic outcomes.
4. Reading comprehension strategy use mediates the negative relationship between performance-avoidance goals and academic outcomes.
5. Reading comprehension strategy use mediates the positive relationship between reading efficacy beliefs and academic outcomes.

The specific hypotheses for the third research question were as follows:

1. Compared to the control group, the growth-mindset intervention group will have stronger incremental beliefs about intelligence.
2. Compared to the control group, the intervention group will have stronger mastery-approach achievement goals.
3. Compared to the control group, the intervention group will have weaker mastery-avoidance achievement goals.

4. Compared to the control group, the intervention group will have weaker performance-approach achievement goals.

5. Compared to the control group, the intervention group will have weaker performance-avoidance achievement goals.

6. Compared to the control group, the intervention group will have greater reading efficacy.

7. Compared to the control group, the intervention group will have a greater reading comprehension strategy use score.

8. Compared to the control group, the intervention group will use more deep-level reading comprehension strategies.

9. Compared to the control group, the intervention group will use more surface-level reading comprehension strategies.

10. Compared to the control group, the intervention group will have greater reading skill.

11. Compared to the control group, the intervention group will have stronger reading comprehension at the textbase.

12. Compared to the control group, the intervention group will have stronger reading comprehension at the situation model.

13. Compared to the control group, the intervention group will have better grades.

Chapter 2

LITERATURE REVIEW

Introduction

The transition from high school to college is challenging, particularly with regard to the rigorous and novel demands of independent learning. For some beginning college learners, the lack of appropriate academic skills and strategic knowledge to effectively respond to the higher level of academic rigor has resulted in poor academic performance (Balduf, 2009; McCabe, 2000; Pressley, Yokoi, van Meter, Van Etten, & Freebern, 1997) and low completion rates (ACT, 2006; Symonds et al., 2011).

One academic skill essential for successful achievement in most, if not all, academic domains is reading comprehension (AEE, 2002; Conley et al., 2011; Heller & Greenleaf, 2007; Snow, 2002). Research reveals a connection between comprehension ability and academic achievement in college, most likely because learners spend a substantial amount of their independent learning time engaged in reading tasks (Bray, Pascarella, & Pierson, 2004; Dreher & Singer, 1985; Royer, Marchant, Sinatra, & Lovejoy, 1990; Snow & Strucker, 2000).

In one study involving 193 second- and third-year undergraduate learners, Jackson (2005) examined the relations among three measures of text comprehension and three measures of academic achievement. The first measure of text comprehension involved learners reading very short passages where a single word was omitted and had to be inferred by the reader. Jackson (2005) used cloze procedures, which are designed to assess learners' use of context clues in tandem with elaboration (i.e., drawing on prior knowledge) or prediction strategies (i.e., using logic to deduce what comes next) to infer the missing word (Valmont, 1983). The second measure of text comprehension was reading recall of passages containing 60 to 80 words. The reading recall comprehension procedure involved participants restating the details of a text immediately after reading it. Learners were assessed on the number of accurate details (i.e., data units) they recalled. The final comprehension measure was participants' ACT reading scores, which had been submitted when they applied to college. Academic achievement was measured by learners' college grade-point-averages (GPAs), course grades, and self-reported high-school GPAs.

Jackson (2005) found that participants' ACT reading scores positively correlated with all measures of academic achievement. Participants' performances on the reading recall comprehension and text comprehension using the cloze procedure assessments were unrelated to any of the measures of achievement. While these findings are drawn from a correlational study, they do indicate an association between academic achievement in college and reading comprehension ability, particularly the ability to comprehend complex texts such as those used during ACT standardized testing. The other measures of reading comprehension ability were unrelated to academic achievement, most likely because the texts did not reflect the types of reading materials used in college-level coursework. For instance, the texts used in the cloze and reading recall procedures were described as "very brief and rather simple texts," while the ACT reading assessment was more "extensive, discriminating, and challenging" (Jackson, 2005, p. 130).

Royer et al. (1990) provide further support for the connection between academic achievement among college students and their ability to comprehend complex academic texts. In two studies, the authors observed that undergraduate learners' comprehension ability was predictive of course grades and GPA. In one, the authors found that learners' comprehension of biology and psychology texts at the beginning of the semester was predictive of course grades earned in their respective courses. That is, if learners were enrolled in one of the biology courses, their comprehension of biology texts was predictive of their course grades. The same was true of enrollment in introductory psychology courses and comprehension of psychology texts. The subject-specific comprehension measures, however, were not predictive of learners' semester or overall GPAs.

In the authors' second study, they found that first-year college learners' comprehension of psychology texts was predictive of their introductory psychology course grades and their overall GPAs throughout their first three years of college. These findings suggest that reading comprehension ability is an essential skill for beginning college learners. Furthermore, learners' comprehension experiences with complex texts during their initial transition to college may set the tone for their undergraduate achievement experiences.

Together, Royer et al. (1990) and Jackson (2005) support the notion that reading comprehension contributes to academic success at college. Beginning college learners' overall college achievement may be at risk if they possess inadequate comprehension skills to make sense of complex college-level texts and steps are not taken to improve their reading comprehension abilities (Bray, Pascarella, & Pierson, 2004). This may be particularly true for learners who believe that the difficulties or failures they experience attempting to comprehend complex texts indicate they do not possess sufficient competence to be successful in college (Dweck, 1999, 2006).

When learners doubt that they have what it takes to succeed in college because they experience difficulty comprehending college-level texts, they may give up and withdraw from their academic pursuits. Dweck (1999) posited that these types of debilitating thoughts stem from learners holding entity theory, or fixed-mindset, beliefs about intelligence. Learners adhering to this system believe that intelligence and ability are innate and that everyone is born with a certain unchangeable amount of intelligence. Conversely, some learners are intrigued when they experience unexpected challenges in college, such as difficulty comprehending complex texts. Instead of giving up, they settle in to devise strategies for succeeding at difficult reading comprehension tasks. Dweck (1999) describes these learners as holding incremental theory, or growth-mindset, beliefs about intelligence. These learners believe people can increase their intelligence by working hard and utilizing strategic knowledge.

The present study sought to shed light on whether teaching learners the growth mindset about intelligence would positively impact their academic mindsets, motivational beliefs, utilization of reading comprehension strategies, and academic outcomes. The upcoming sections provide the theoretical context for this research. An overview of how reading comprehension and strategic reading comprehension processes are conceptualized is provided first in order to situate this research.

Constructionist Model of Reading Comprehension

Successful comprehension of texts, which is different from the ability to decode words or read texts fluently, involves the integration of numerous skills and strategies accumulated over the lifespan to read, process, and understand the meaning of texts. Decoding and fluency support reading comprehension and involve the use of rudimentary skills such as awareness of individual letters and letter combination sounds, translation of written words into sounds and smooth quick reading (Alexander, 2005; Artelt, Schiefele, & Schneider, 2001; Cromley & Azevedo, 2007; McNamara, Ozuru et al., 2007; Snow, 2002). In general, these basic skills are mastered during the elementary school years (Snow, 2002).

Comprehension of texts, however, requires the use of higher-level cognitive processes that allow readers to learn from texts by integrating what is being read with their prior knowledge, so they can construct a cohesive mental representation or model of the ideas and concepts presented in the text (Alexander, Kulikowich, and Schulze, 1994; Kendeou, van den Broek, Helder, & Karlsson, 2014; Kintsch, 1988; McNamara, 1997; McNamara & O’Reilly, 2009). College learners’ ability to generate accurate and detailed mental representations of text is dependent upon the sophistication of their strategic processing within and beyond the text (Graesser, Millis, & Zwaan, 1997; van Dijk & Kintsch, 1983).

Literature on advanced reading comprehension has shown that two reading-related factors exert a substantial amount of influence on reading comprehension success: (1) the knowledge college learners possess prior to engaging in reading tasks (Cottrell & McNamara, 2002; Murphy & Alexander, 2002; Shapiro, 2004); and (2) readers' reading comprehension ability (Alexander, Graham, & Harris, 1998; Cottrell & McNamara, 2002; Murphy & Alexander, 2002).

Prior knowledge is believed to be important for successful reading comprehension because it helps readers contextualize what they read, particularly when text is designed to be expository or informative (Cottrell & McNamara, 2002; McNamara, 2004; Shapiro, 2004). Expository text, such as the type used in most college courses, is designed to provide the reader with select information to learn about an event, situation, or procedure (Duke, 2004; Fox, 2009). Reading comprehension ability is also important because it is indicative of learners' use of strategic comprehension processes, such as continuously monitoring one's understanding and generating questions to ensure thorough comprehension of the details and conceptual relationships within and beyond the target text (Cottrell & McNamara, 2002; Pressley, 2000; Underwood, 1997). The present research focused on beginning college learners' use of strategic comprehension processes to succeed at college-level reading tasks, specifically the comprehension of expository academic texts.

One cognitive model of reading comprehension that has received significant attention in contemporary reading comprehension research is the constructionist model (Alexander et al., 1994; Kendeou et al., 2014). One feature that distinguishes it from other cognitive models of reading comprehension is the preeminence ascribed to the role of reading strategies in advancing readers' comprehension of complex texts. Specifically, the constructionist model emphasizes readers' continuous use of metacognitive monitoring and reading comprehension strategies to formulate a cohesive representation of text as it is read (Graesser, 2007).

Metacognitive Monitoring

Proficient metacognitive monitoring of one's understanding of a text is widely regarded as essential for successful comprehension of complex texts (Heller & Greenleaf, 2007; Pirolli & Recker, 1994). In general, metacognition is often described as thinking about thinking, and it involves awareness of how to respond to difficulties that arise in order to strategically influence the attainment of one's goals (Flavell, 1979). Specific to reading, metacognitive monitoring involves readers' knowledge about specific reading tasks, themselves as learners and readers, and reading comprehension strategies. Metacognitive readers draw upon these three sources of knowledge to respond to difficulties they encounter while reading (Forget & Morgan, 1997; Pressley, 2000; Underwood, 1997). For example, a metacognitive reader may recognize that assigned readings in college require a higher level of comprehension for new ideas and concepts than leisure reading of novels and magazines (task knowledge). A metacognitive reader may also realize that he or she struggles when asked to connect ideas from one text to another (knowledge of self). In response to these challenges, a metacognitive reader might decide to identify all the main concepts, then clarify the shared and contrary ideas and concepts in both texts (knowledge of reading comprehension strategies).

Metacognitive readers use these types of awareness to continually monitor their progress in understanding text by comparing their current state of text comprehension to their desired state of text comprehension. When metacognitive readers discern a deficit in their ability to comprehend text, they utilize reading comprehension strategies to rectify perceived shortcomings. According to the constructionist model of reading comprehension, in addition to metacognitive monitoring of comprehension, cognitive reading strategies also play a major role in successful complex text comprehension (Heller & Greenleaf, 2007; Rapp, van den Broek, McMaster, Kendeou, & Espin, 2007).

Reading Comprehension Strategies

Reading comprehension strategies, sometimes referred to as cognitive reading strategies, are the conscious efforts readers use to respond to difficulties they encounter while trying to comprehend texts (Rapp et al., 2007). Empirical evidence indicates that when readers consistently use cognitive strategies, such as periodically summarizing text while reading, clarifying understanding of new concepts, questioning conceptual relationships to determine the central ideas of the text, and generating predictions by activating prior knowledge to ensure new information is in harmony with what they already know, their ability to learn from text is significantly improved (Alfassi, 2004; Gruenbaum, 2012; Guthrie et al., 2004; McNamara et al., 2007; Snow, 2002; Souvignier & Mokhlesgerami, 2006; Spörer & Brunstein, 2009; Wolfe & Goldman, 2005).

Three major premises undergird the constructionist model of reading comprehension (Graesser, 2007). As previously stated, readers' continuous use of metacognitive monitoring and reading comprehension strategies are integral throughout every facet of the model.

Reading Goals

The first major premise of the constructionist model emphasizes that learners engage in reading tasks and use comprehension strategies differentially based upon their purposes or goals for reading (Graesser, 2007). This may explain why complex college-level reading tasks can present a challenge for beginning college learners. Since beginning college learners may have had fewer opportunities to read for the purpose of independent learning from text during high school, they may possess insufficient knowledge about the necessity of establishing goals for reading beyond the memorization of key concepts (Simpson & Nist, 2000). Furthermore, they may not have yet developed the cognitive or metacognitive strategies they need to support independent learning from text.

Learners' Representation of Texts

The second major premise of the constructionist model is that learners use metacognitive and reading comprehension processing strategies to continuously construct a coherent, organized, and meaningful mental representation of text as they progress moment to moment through the text (Barth, Barnes, Francis, Vaughn, & York, 2015; Graesser, 2007; Kendeou et al., 2014; McMaster, Espin, & van de Broek, 2014). Learners' representation of text may occur at three levels based upon their comprehension goals and their strategic processing knowledge: the surface code, the textbase, and the situation model (Graesser et al., 1997; van Dijk & Kintsch, 1983).

Surface code. The first level of text representation is the surface code. At the surface code, readers retain an exact representation of the text as it is written. If the processing of complex college-level texts remains at this level, comprehension is stymied because readers resort to rote memorization of specific words stated within individual clauses or sentences (Graesser et al., 1997; Linderholm, Therriault, & Kwon, 2014). Furthermore, the usefulness of surface code information is limited to readers' immediate memory, since it is not integrated into readers' mental representation of the entire text (Barth et al., 2015; Kendeou et al., 2014; Magliano, Trabasso, & Graesser, 1999). This represents surface-level processing of text.

Textbase. The second level of text representation is the textbase. At the textbase, learners' representation of text is limited to individual or adjoining clauses and sentences (local coherence). Unlike the surface code level, however, readers substitute their own language to represent the original text (Haenggi & Perfetti, 1994; Kendeou et al., 2014; Kintsch, 1994). While text representations at the level of the textbase represent surface-level strategic processing, they do add to learners' comprehension of the text by starting the process of clarifying or connecting proximate ideas presented within the text (Barth et al., 2015). Textbase surface-level strategic comprehension processes that support learners' ability to respond to "why" questions include the generation of paraphrases and simple bridging inferences (King, 2007; Linderholm et al., 2014). Paraphrases are learners' restatements of single clauses or sentences of text in their own words. Simple bridging inferences are generated when learners connect ideas within multiple sequential or proximate sentences within the text.

Situation model. The third level of text representation is the situation model or mental model. At this deeper level of strategic text processing, learners are able to construct complex and detailed mental representations of text by connecting text segments that are separated by distance within the text (global cohesion), as well as by drawing on knowledge they may have about the topic and other related world experiences (Kendeou et al., 2014; McMaster et al., 2014; Oakhill, Cain, & Bryant, 2003; van den Broek, White, Kendeou, & Carlson, 2009). Successful comprehension enables the reader to dynamically construct accurate and detailed representations of text at the situation model that are continuously revised as new information is acquired while reading (Barth et al., 2015; Kendeou et al., 2014). Deep-level strategic comprehension processes at the situation model support learners' response to "why" questions through the generation of elaborative inferences that connect what is being read to learners' prior knowledge. Deep-level comprehension processes also consider text at the global level, utilizing sophisticated bridging inferences that integrate ideas dispersed throughout the text (Barth et al., 2015; Kendeou et al., 2014; McMaster et al., 2014; Oakhill et al., 2003; van den Broek et al., 2009).

Self-Explanations

The final major premise of the constructionist model of reading comprehension is that the level of strategic comprehension processing learners employ during and after reading texts influences their ability to generate self-explanations of their mental models of the text (Graesser, 2007; Magliano et al., 1999). The accuracy, quality, and quantity of the self-explanations learners generate are indicative of the degree to which they comprehend what they have read (Chi, de Leeuw, Chiu, & Lavancher, 1994). Learners with proficient comprehension skills strategically seek out and integrate details within and beyond the text to explain "why" questions, such as why situations or logical relationships exist or why particular details are important or worthy of inclusion in the mental model (Graesser, 2007; Magliano et al., 1999; Spring, 1985). The process of self-explanation is active and involves learners consciously explaining the text to themselves throughout the entire reading process (Chi, de Leeuw, Chiu, & Lavancher, 1994; McNamara, 2004; McNamara & Scott, 1999; Shapiro, 2004).

Sometimes, learners may experience difficulty generating an accurate or complete mental representation of the text. This occurs when they lack sufficient skills to access prior knowledge, generate appropriate inferences that are aligned with the goals of complex reading tasks, or continuously monitor the condition of their comprehension (Kendeou et al., 2014; McMaster et al., 2014; van den Broek, Bohn-Gettler, Kendeou, Carlson, & White, 2011; van den Broek & Espin, 2012).

Beginning college learners' ability to respond appropriately to challenges that arise while reading complex texts may be dependent upon several motivational factors and may ultimately impact their academic achievement and progress. In the next section, the social cognitive theory is introduced as the theoretical framework conceptualizing the role of motivation in understanding college learners' responses to difficulties comprehending challenging texts. Despite the popularity of institutional theories in college-based achievement literature (Tinto, 1975, 1993; Tinto & Pusser, 2006), social cognitive theory was used for the present research because it offers a holistic perspective that accounts for a broad range of internal and external factors that influence learning and achievement.

Social Cognitive Theory

Many individuals and academic institutions have sought ways to improve the likelihood that beginning college learners will complete college. One of the most commonly applied perspectives used to investigate the achievement outcomes of learners who experience difficulties as they transition from high school to college completion is Tinto's (1975) student integration model of institutional departure. This model highlights the role of learners' background variables (e.g., family, high-school achievement, employment status, social skills, etc.) and social experiences at college as significant predictors of learners' commitment to their collegiate goals (Tinto, 1975, 1993; Tinto & Pusser, 2006). One significant criticism of Tinto's (1975) model is that it only addresses traditional college learners attending four-year residential institutions (Pascarella & Chapman, 1983; Towles & Spencer, 1993). Additionally, Brunsden, Davies, Shevlin, and Bracken (2000) suggest that Tinto's (1975) model might be enhanced by placing greater emphasis on learners' perspectives by "identifying the specific reasons and circumstances that surround an individual's decision to withdraw" (p. 307). In other words, Tinto's (1975) perspective does not explain the psychological processes related to students' withdrawal from college. Such a theoretical expansion might reveal individual factors that play a role in college leaving. For instance, it is possible some individuals withdraw from college because their beliefs about intelligence lead them to doubt their ability to learn how to fulfill a general prerequisite for college success: comprehension of vast numbers of complex college-level texts.

One alternative to Tinto's (1975) model is the social cognitive theory, which provides a holistic template for examining how beginning college learning experiences (e.g., reading comprehension tasks and reading comprehension strategy instruction), personal factors (e.g., beliefs and goals), and academic behaviors (e.g., reading strategy use) influence academic achievement (Pintrich & Schunk, 1996, 2002; Schunk, 1989). Similar to Tinto's (1975) model, it examines the impact of background variables and learning experiences within college environments, but it has the added advantage of taking into consideration learners' motivational and self-regulatory processes, specifically their beliefs (Dweck, 2006; Dweck & Molden, 2005), goals (Eccles & Wigfield, 2002; Kaplan, Middleton, Urdan, & Midgley, 2002; Pintrich, 2000b), and academic behaviors (Vrugt & Oort, 2008; Zimmerman & Kitsantas, 2005).

The present research was framed within Dweck's (1999) social cognitive theory of motivation and learning, which emphasizes the role of several underlying psychological processes in explaining learning and performance. Specifically, learners' beliefs about the nature of intelligence and ability influence their efficacy beliefs and the competency goals they pursue in academic settings. In turn, efficacy beliefs and competency goals covertly orient learners' choice of academic behaviors. Finally, academic environments can impact learners' motivational beliefs and academic behaviors.

Learners' Beliefs and Thoughts

The first component of the social cognitive theoretical framework addresses the influence of psychological processes on learning (Pintrich & Schunk, 1996, 2002). Specifically, learners' implicit beliefs about intelligence, along with their experiences and interpretations of successes and failures, contribute to the formation of their self-efficacy beliefs, which are learners' judgments about their ability to successfully complete specific tasks (Wood & Bandura, 1989). These beliefs are particularly important when impediments to learning arise. Learners' implicit beliefs about intelligence also contribute to the orientation of their achievement or competency goals (Dweck, 1999). When learners believe that intelligence is malleable, they are more likely to avidly pursue learning as much as possible. When challenges emerge, they are likely to pursue skill development and self-improvement. When learners believe that intelligence is dictated by DNA, they are more likely to pursue normative levels of task mastery. Accordingly, when challenging situations arise, they are likely to avoid difficult tasks that reveal their shortcomings (Dweck, 2006). The next subsections address the literature on intelligence beliefs, self-efficacy beliefs, and achievement goals in relation to reading comprehension and academic achievement.

Implicit beliefs about intelligence. Dweck (1999, 2006) posited that learners maintain underlying beliefs or implicit theories about the nature of intelligence and ability. In academic environments, these systems of belief about intelligence serve as filters through which learners view themselves and others' abilities in relation to academic tasks. Dweck's (1999) model describes two academic mindsets about intelligence that orient learners' thinking about intelligence.

The first mindset about intelligence is a fixed mindset, also referred to as an entity theory of intelligence. Learners who maintain a fixed mindset of intelligence believe that intelligence is static, is dictated by heredity, and cannot be improved through effortful pursuits (Dweck & Grant, 2008; Molden, Plaks, & Dweck, 2008; Nussbaum & Dweck, 2008). Maintaining a fixed mindset can be debilitating for beginning college learners who are confronted with unexpected academic challenges (e.g., failed attempts at comprehending complex texts) because their underlying beliefs promote a sense of helplessness (Dweck, 1999; Silva & White, 2013). Learners maintaining fixed-mindset beliefs do not believe that practice, strategic experimentation, or increasing one's efforts can substantially change academic or reading comprehension performances. For them, a person either has or does not have what it takes to be successful at comprehending college-level reading tasks.

The second mindset about intelligence is the growth mindset or incremental theory of intelligence. Learners who adhere to a growth mindset believe that intelligence is malleable and that it can be improved over time through practice that is coupled with strategic effort and knowledge (Dweck, 1999, 2006; Dweck & Leggett, 1988; Dweck & Molden, 2005). Maintaining an academic mindset that expresses the belief that increasing one's strategic efforts at problem solving can improve one's academic prowess is beneficial, particularly when learners are tackling novel tasks or challenging levels of academic rigor (Yeager et al., 2013). When confronted with challenging college-level texts, learners with growth-mindset beliefs believe that their effort expenditures will pay off, so they are motivated to earnestly endeavor, experiment with strategic tools and resources, and persist to achieve comprehension success.

Implicit beliefs about intelligence and reading comprehension. Although implicit beliefs about intelligence are believed to have an impact on reading comprehension and academic performances, the literature regarding college learners' intelligence beliefs and reading comprehension outcomes is sparse. One study conducted in Norway examined how implicit beliefs about intelligence influenced the use of multiple document comprehension among 59 learners completing college preparatory courses (Braasch et al., 2014). Although the participants were not college students at the time of the study, their average age was 17.96, which is close in age to beginning college learners, and the participants were preparing to transition to college. The authors examined how several factors, including learners' implicit beliefs about intelligence (fixed and growth mindsets), prior knowledge, word recognition, and working memory influenced learners' performances on two challenging tasks: an essay and multiple document inference verification. Learners were asked to read six texts about El Niño and weather patterns in the Pacific Ocean. Three documents were more useful (i.e., texts derived from a textbook, magazine, and research website) and three were less useful (i.e., texts derived from a freelance writer's blog, an editorial commentary, and a global astrologer's newsletter). After reading the documents, learners were given 20 minutes to write an essay to "explain the causes of the typical weather patterns in the Pacific Ocean and the processes that make El Niño change these weather patterns" (Braasch et al., 2014,

p. 14). Essays were scored based on the accurate inclusion of 30 concepts described in the three more useful documents. After the essay task, learners were also asked to verify the accuracy of 20 bridging inferences that linked concepts across the three more useful documents. Seven inferences were accurate, and 13 inferences were invalid.

Regression analysis showed that the full model with all predictor variables (i.e., fixed and growth mindset, prior knowledge, word recognition, and working memory) significantly explained the variance in the number of concepts learners included in their essays, as well as the accuracy of their verifications of the bridging inferences. Analysis of the unique variance attributable to each of the predictor variables, however, showed that only growth mindset significantly explained the variances in learners' performances on both comprehension tasks. Fixed mindset did not significantly explain the variance in either comprehension task while prior knowledge significantly explained the variance in essay task scores. Working memory significantly explained the variance in inference verification task scores.

The results from Braasch et al.'s study (2014) align with other research indicating that learners' maintenance of growth mindsets is related to the use of strategic knowledge to support learning and achievement (Blackwell, Trzesniewski, & Dweck, 2007; Burnette et al., 2013; Dweck & Molden, 2005). The findings regarding fixed mindset, however, do not align with other research (Blackwell et al., 2007; Burnette et al., 2013; Robbins & Pals, 2002) that suggests learners maintaining entity intelligence beliefs are likely to disengage and enact strategies that undermine achievement in response to challenging tasks. One possible explanation for the atypical findings regarding entity beliefs is that certain aspects of Dweck's (1999) theoretical model may be subject to cultural norms. Specifically, Undheim, Nordvik, Gustafsson, and Undheim's (1995) study (as cited in Braasch et al., 2014) describes the Norwegian educational culture as an egalitarian system that plays down individual academic differences and competition. As a result, learners maintaining entity beliefs may be less likely to feel threatened by challenging tasks. The lack of threat to their perceived intelligence may diminish the likelihood of entity beliefs resulting in adverse academic behaviors.

No other studies were found that addressed Dweck's (1999) theoretical model regarding college learners' reading comprehension. In a closely related investigation, however, Greene et al. (2010) examined changes in 171 college learners' conceptual understanding of the human circulatory system after engaging with three texts in a hypermedia learning environment. Greene et al. (2010) measured learners' implicit beliefs about intelligence using a three-item, six-point Likert scale ranging from "strongly agree" to "strongly disagree." The three items reflected an entity view such that a high score on the measure indicated an orientation toward incremental beliefs, while a low score indicated an orientation toward entity beliefs. Learners' conceptual understanding was measured immediately before and after they engaged with the hypermedia texts by assessing the accuracy of their descriptions of the component parts of the circulatory system and the completeness of their mental model regarding its purposes and functioning.

Path analyses showed that learners' implicit beliefs about intelligence were directly and indirectly related to their performances on the assessment that measured conceptual understanding, which took place after the hypermedia learning. Learners who maintained higher incremental beliefs about intelligence earned higher scores on their conceptual understanding assessment. The nature of the observed indirect relationship was somewhat unexpected in that while greater use of strategic processing contributed to higher conceptual understanding scores, on average, learners maintaining higher incremental beliefs used fewer strategic learning processes than those maintaining lower incremental beliefs. This finding contradicts Dweck's (1999) theoretical model, which advocates that incremental beliefs about intelligence facilitate achievement by way of adaptive competence goals and the use of strategic processing.

The above literature indicates that the influence of implicit beliefs about intelligence on reading comprehension (and conceptual understanding) occurs through the mediating role of strategic processing of text (Blackwell et al., 2007; Burnette et al., 2013; Dahl, Bals, & Turi, 2005; Robbins & Pals, 2002). That is, implicit beliefs influence the quality of the strategic efforts learners apply to comprehend difficult texts. In turn, the quality of learners' strategic efforts are likely to play a pivotal role in whether they experience success or failure. Consequently, self-efficacy beliefs, which are primarily cued by experiences of success and failure and are a key component of social cognitive theory (Bandura, 1986) are likely to be influenced by learners' implicit beliefs about intelligence (Wood & Bandura, 1989).

Self-efficacy beliefs. Intelligence beliefs appear to play a role in how learners interpret the feedback they receive regarding their abilities and their subsequent judgments of what they can do. Generally speaking, self-efficacy beliefs, which are derived from several sources, are personal judgments about one's ability to succeed at particular tasks or in specific domains (Bandura, 1978, 1986; Schunk, 2003; Schunk & Zimmerman, 1997; Usher & Pajares, 2006). The primary source of self-efficacy beliefs for learners is their prior experiences of success and/or failure in completing similar types of academic tasks. Feedback and encouragement received from teachers and others whose opinions and judgments learners trust also contribute to self-efficacy beliefs (Bandura, 1986).

Efficacy beliefs are domain-specific and may be examined with regard to succeeding at specific tasks or more broadly within an area of study depending upon the focus of the research investigation (Pajares, 1996). Accordingly, the present study assessed reading efficacy, which reflects learners' confidence that they can successfully understand the texts they read (Anmarkrud & Bråten, 2009).

While there is a great deal of literature on reading motivation, most studies attend broadly to reading efficacy beliefs (e.g., including efficacy for extracurricular reading) among elementary school age students (Guthrie, Hoa, Wigfield, Tonks, Humenick, & Littles, 2007; Guthrie, Wigfield, Metsala, & Cox, 1999; Wang & Guthrie, 2004; Wigfield & Guthrie, 1997). One study examined general reading efficacy beliefs among beginning college learners in a developmental reading class (Cantrell et al., 2013). Cantrell et al. (2013) conducted a correlational comparative analysis of the reading efficacy beliefs between 59 college learners who were required to take a developmental reading course and 41 college learners who were enrolled in a credit-bearing English course. In line with Bandura (1986), the authors found that learners from both groups identified prior task-mastery experiences as the greatest source of reading efficacy. Also, learners in the developmental course had lower reading efficacy beliefs than their peers in the college-level English course, with a mean difference of 3.742 (SE = 1.171, $p < .01$). One limitation of Cantrell et al.'s study (2013) is that it does not connect to other achievement motivation constructs or learner outcomes. In addition, although Cantrell et al.'s study (2013) addressed college learners' reading efficacy beliefs, their measure extends beyond the parameters of this research in that it includes items pertaining to confidence for reading non-academic materials, performing well on standardized tests, and getting good grades. As a result, this reading efficacy measure was not adopted for this research.

One study specifically addressed reading efficacy beliefs for academic texts among slightly younger learners, 14 to 15 years of age. Anmarkrud and Bråten (2009) examined whether reading efficacy predicted comprehension of social studies texts among 104 learners. The researchers found that reading efficacy was significantly correlated with learners' topical knowledge ($r = .36$, $p < .001$) and self-reported use of deep-level reading strategies ($r = .26$, $p < .01$), use of surface-level strategies ($r = .29$, $p < .01$), and self-reported social studies grades from the previous semester ($r = .52$, $p < .001$). These findings support Dweck (1999). Subsequent three-step hierarchical regression analyses, however, showed that reading efficacy ceased to be a significant predictor of reading comprehension when it was added into the model during the final step (i.e., after gender, achievement, topic knowledge, deep strategies, surface strategies), ($\beta = .12$, $p > .05$). These results may be due to reading comprehension's significant positive correlation with the variables mentioned above, particularly topic knowledge, which significantly predicted reading comprehension in the final step of the analyses (β = .44, $p < .01$).

One of the strengths of Anmarkrud and Bråten's (2009) study in relation to the present study is the measurement of reading efficacy in terms of perceived capacity for comprehension of academic texts. Although there is a slight difference in the age of the study participants, this measure is appropriate for students who have just graduated from high school. Accordingly, Anmarkrud and Bråten's (2009) reading efficacy measure was used in this research.

No studies were found that addressed reading efficacy and intelligence beliefs. However, maintaining beliefs that intelligence is uncontrollable may lead learners who experience difficulty comprehending complex college-level texts to perceive errors and failed attempts as indicators of low ability, which may subsequently chip away at their efficacy beliefs (Dweck, 1999). Learners who maintain fixed beliefs and low expectations regarding their ability to successfully cope with academic difficulties may become susceptible to giving up on challenging reading tasks altogether and may ultimately alter their academic goals (Hong et al., 1999). Dweck (1999) refers to this response pattern as "helplessness," which is associated with remarks such as, "I guess I'm not very smart" and "I'm not good at things like this" (p. 7). If learners ascribe these types of remarks to their reading comprehension experiences in college, it may be difficult for them to persist toward degree attainment. Dweck (1999) explains that

> within an entity-theory framework, no matter what your confidence is, failure and difficulty still imply low intelligence. The whole framework with its emphasis on measurement and judgment gives a meaning to negative outcomes (and to effort)

> that is undermining to students — even if they entered a situation feeling fine about their intelligence. (p. 51)

In contrast, maintaining incremental theory beliefs that focus on the malleability of intelligence through strategic efforts to acquire new skills supports learners' acceptance of mistakes and failed attempts at reading comprehension as part of the learning process. Dweck (1999) refers to this response pattern as "mastery-oriented." When learners perceive every mistake as a part of the learning process that brings them one step closer to successful task mastery rather than as indicators of low ability, their self-efficacy for learning beliefs may be insulated while they undertake multiple attempts at succeeding in difficult reading tasks. The impact of this response pattern on self-efficacy for learning beliefs is evident in learners stating, "I've almost got it now," or making a request for "more chances on a problem because they felt sure they were on the verge of getting it" (Dweck, 1999, p. 10).

Specific to the present study, the researcher hypothesized that maintaining growth-mindset beliefs would foster resilient reading efficacy beliefs regarding academic texts. Learners maintaining growth-mindset beliefs will likely believe they can respond adaptively when their comprehension is hindered by difficult texts to bounce back and succeed at learning. Conversely, the researcher hypothesized that maintaining fixed-mindset beliefs would undermine learners' reading efficacy, leading them to believe they lacked the capacity to successfully comprehend challenging complex academic texts. Repeated experiences of difficulty and/or failure comprehending college-level texts are likely to validate entity theorists' self-perceptions of reaching an insurmountable ability threshold and hinder strategic responsiveness.

Wood and Bandura (1989) provide supporting evidence for the influence of implicit beliefs about intelligence on a different domain of self-efficacy beliefs. The authors examined the impact of implicit theories about intelligence on self-regulatory processes, including self-efficacy beliefs about organizational decision-making, of 24 graduate students in a business course. The experiment involved manipulating learners' implicit theories about intelligence toward incremental or entity beliefs while they completed an 18-week organizational management simulation. Learners were provided with weekly tasks and unattainable performance standards during the simulation. Learners in the incremental treatment condition were told that the purpose of the simulation was to provide practice that would help them develop and improve their organizational management decision-making skills. Learners in the entity treatment condition were told that the ability to make good decisions was indicative of cognitive ability and that the simulation would gauge their underlying cognitive abilities. Learners' self-efficacy beliefs, strategy use, and performance were tracked over the course of the 18-week simulation at six-week intervals.

The researchers found that the implicit theory treatment conditions predicted learners' efficacy beliefs over time. While both groups of learners began the simulation with high efficacy beliefs, the experience of repeated failure impacted each group differently. Learners in the incremental treatment group were resilient in that they maintained their high self-efficacy beliefs. They also maintained a methodic use of strategies and a high level of performance despite failing to attain the preset standards. In stark contrast, learners in the entity treatment group evidenced a dramatic decrease in self-efficacy beliefs. They also began to indiscriminately enact strategies and experience consistent declines in productivity over the course of the simulation.

Efficacy beliefs may also have a direct impact on academic achievement among college learners. Zimmerman and Kitsantas (2007) examined the predictive strength of self-efficacy for learning on the homework quality and course grades of 223 college learners enrolled in an educational psychology course. Homework quality was self-reported and reflected the degree to which learners engaged in strategic homework practices, such as prioritizing homework tasks and having a regular place to study. The researchers found that self-efficacy for learning was positively correlated with homework quality ($r = .55$, $p < .01$) and course grades ($r = .58$, $p < .01$). Furthermore, self-efficacy for learning was found to be a significant contributor for explaining the variance in learners' homework quality and course grades they earned. Stepwise multiple regression analyses showed that self-efficacy for learning explained an additional 22% of the variance in the quality of learners' homework, which is above the 12% explained by their Standardized Achievement Test (SAT) scores (total $R^2 = .34$). In separate analyses, self-efficacy for learning also explained an additional 24% of the variance in learners' course grades, which is above the 11% explained by SAT scores (total $R^2 = .35$).

In a closely related area of self-efficacy beliefs, Phan (2009b) found that general academic self-efficacy beliefs were also related to academic achievement. In a correlational study, Phan (2009b) measured learners' general academic self-efficacy pertaining to a specific course (e.g., “I am certain I can understand what is taught in educational psychology”) as well as their self-reported use of deep-level (e.g., elaboration and organization) and surface-level (e.g., rote memorization) strategies to examine what contributions, if any, these factors made to academic achievement. Academic achievement was measured by the sum of learners’ scores on course assessments. Path analyses showed that general academic self-efficacy beliefs made a direct positive contribution to learners’ self-reported use of deep-processing strategies, which in turn had a direct positive influence on academic achievement. General academic self-efficacy beliefs, however, were unrelated to learners’ reported use of surface-level processing strategies, which was unrelated to achievement outcomes. These findings suggest that the use of deep-level processing strategies is more likely to be used by learners with high self-efficacy beliefs, whereas the use of surface-level processing strategies is likely to be used equally among all learners without regard to the status of their efficacy beliefs. Furthermore, it appears that reliance on surface-level strategies is not productive in terms of influencing learners’ performances on course assessments.

In the present research, it was anticipated that reading efficacy beliefs would positively contribute to learners’ use of deep-level strategic reading comprehension processes and academic achievement. While no reading comprehension studies were found that focused on these measures, other research (Kitsantas & Zimmerman, 2009; Phan, 2009b; Wood & Bandura, 1989; Zimmerman & Kitsantas, 2007) supports the notion that learners’ efficacy beliefs may affect their strategic behaviors when problems arise during the course of learning from complex texts, including their use of deep-level reading comprehension processing strategies.

In addition to reading efficacy, learners' competency pursuits or achievement goals may also play a role in determining their strategic responses. Dweck (1999, 2006) asserts that in addition to affecting efficacy beliefs, learners' implicit beliefs about intelligence also influence achievement goals.

Achievement goals. Achievement goals are a broad set of underlying thoughts learners have about self, academic tasks, and desired academic outcomes that direct their academic behaviors (Kaplan et al., 2002; Vrugt & Oort, 2008). These underlying thoughts are indicative of learners' pursuits for particular competency outcomes (Elliot & Murayama, 2008; Elliot & Thrash, 2001).

According to Dweck's (1999) theoretical model, learners' implicit beliefs about intelligence are antecedent to the development of particular patterns of achievement goals. Specifically, in achievement settings, learners who believe they can play an active role in improving their intelligence and abilities (growth mindset) are likely to focus on learning as much as possible and emphasize developing their skills and improving themselves, which orients them toward pursuing mastery achievement goals (Dweck, 1999, 2006; Dweck & Leggett, 1988; Stipek & Gralinski, 1996). Conversely, learners who believe intelligence and ability are innate (fixed mindset) are likely to be oriented toward pursuing performance goals. Their belief that each person possesses a limited amount of intelligence creates a personal imperative to demonstrate that they possess sufficient competence on par with or above their peers (Cury, Elliot, Da Fonseca, & Moller, 2006; Dweck, 1999, 2006; Dweck & Master, 2009).

As indicated above, Dweck's (1999) framework delimits two broad categories of goal-oriented motivational beliefs that direct learners' intentions regarding academic tasks: mastery and performance goals. Mastery goals are considered adaptive in that they facilitate the implementation of achievement behaviors that support persistence, striving, and favorable academic outcomes in the face of academic challenges (Ablard & Lipschultz, 1998; Dweck, 2006; Dweck & Leggett, 1988; Heyman & Dweck, 1992; Pintrich & De Groot, 1990). Learners who endorse mastery-oriented goals consider self-improvement, increased understanding, and the development of new skills to be desirable competency pursuits (Ames, 1992; Anderman & Maehr, 1994). With these goals in mind, it is possible that mastery-oriented beginning college learners may be motivated to expend the additional time necessary to engage in strategic efforts, such as experimenting with the use of deep-level reading comprehension processing strategies to improve their comprehension of challenging college-level texts (Ranellucci, 2013).

In contrast to mastery-oriented goals, performance-oriented goals are viewed in Dweck's (1999) model as counterproductive in terms of facilitating favorable learning performances (Dweck & Leggett, 1986; Nolen, 1988; Pintrich & Schunk, 1996). Viewed broadly, performance-oriented goals draw learners' attentions away from acquiring task-related competencies (i.e., task mastery, skill development, and self-improvement) to pursuing particular levels of competence in relation to "others" (Dweck, 1999; Nicholls, 1984; Pintrich, 2000b). The desire to pursue competence in relation to one's peers may be indicative of learners' concerns or needs to validate that they possess sufficient competence (Elliot, 1999). Thus, it is possible that college learners with performance goals may be encumbered by a personal imperative to protect themselves from negative evaluations of their performance on difficult reading tasks, particularly if those tasks threaten to expose reading comprehension weaknesses (Dweck, 2006).

Contemporary achievement goal theory research has sought to distinguish whether differences in learners' attraction or aversion to particular competency pursuits makes a difference in achievement motivation. Initial efforts were directed at performance goals, which resulted in the identification of two subcategories of performance-oriented goals and the creation of a trichotomous, or three-factor, achievement goal model, including mastery goals, performance-approach goals, and performance-avoidance goals (Eccles & Wigfield, 2002; Grant & Dweck, 2003; Linnenbrink, 2005; Kaplan et al., 2002; Pintrich, 2000b). In general, both performance-approach and performance-avoidance oriented learners measure their success on academic tasks based upon how well they do in comparison to their peers (Elliot & McGregor, 2001). When challenging situations arise, however, the two subtypes diverge. In challenging situations, performance-approach goals may motivate learners to seek out opportunities to acquire normative levels of competence while performance-avoidance goals are likely to motivate learners to avoid experiences that may expose their perceived subpar competence.

Subsequent efforts also have been made to distinguish approach and avoidance mastery goals. Within both subtypes of mastery goals, learners seek absolute or complete mastery of tasks or pursue self-improvement or skill development (Elliot, 1999; Elliot & Thrash, 2001). Similar to the performance goal subtypes, mastery goals are further distinguished by whether learners' competency goals are approach-oriented, reflecting a desire to pursue opportunities for task mastery, self-improvement, and skill development, or avoidance-oriented, reflecting a desire to avoid experiencing the inability to master tasks, realize self-improvement, or retain and/or develop their skills (Elliot, 1999; Elliot & Thrash, 2001; Kaplan & Maehr, 2007).

To date, most of what we know about mastery-oriented goals pertains specifically to mastery-approach goals (Elliot, 1999). Specifically, most contemporary research in achievement motivation has employed the trichotomous model of achievement goals. This study, however, employed Elliot and Murayama's (2008) 2x2 achievement goal conceptualization to account for the mastery-avoidance orientation. The 2x2 achievement goal framework includes performance-approach goals, performance-avoidance goals, mastery-approach goals, and mastery-avoidance goals.

Mastery-avoidance goals are germane to the present research because the avoidance component of learners' goals may prompt a unique pattern of academic behavior in comparison to mastery-approach goals (Baranik et al., 2010). Specifically, beginning college learners are transitioning to novel and rigorous academic environments, where they are expected to "hit the ground running" by fully engaging in independent learning activities, such as learning from complex academic texts. When presented with reading comprehension challenges, setbacks, and failures where task mastery progress is not readily apparent, mastery-avoidance oriented learners may elect to divert their energies from using time- and effort-intensive deep-level reading comprehension processing strategies to surface-level strategies to avoid failure and "get by" (Baranik et al., 2010).

Emerging evidence suggests that although learners maintaining mastery-avoidance goals enjoy the benefits of task- and self-referenced learning pursuits, the avoidance feature makes these goals far less desirable than mastery-approach and possibly even performance-approach goals (Baranik et al., 2010; Burnette et al., 2013). For instance, Baranik et al. (2010) conducted a meta-analysis of research on achievement goals to assess the construct validity of the four goal orientations in Elliot and McGregor's (2001) 2x2 achievement goal framework. They also investigated whether the mastery-avoidance goal construct was conceptually and empirically distinct from the other goal constructs.

Baranik et al. (2010) examined the relations among the four achievement goals and the following eight theoretically relevant variables: (1) cognitive ability, (2) need for achievement, (3) perceived competence, (4) competitiveness, (5) interest, (6) positive and negative affect, (7) help-seeking, and (8) performance. The first six variables were theorized to predict achievement goals and the latter two were outcome variables. The authors concluded that the mastery-avoidance construct was conceptually and empirically distinct from the other achievement goal constructs in that it displayed a unique pattern of relations. They also found that while maintaining mastery-approach goals positively correlated with strategic help-seeking, maintaining mastery-avoidance goals negatively correlated with strategic help-seeking. Furthermore, mastery-avoidance goals appeared to be detrimental to achievement. Contrary to Dweck (1999), Baranik and colleagues (2010) found that along with mastery-approach goals, performance-approach goals were also positively related to achievement. More interestingly, both performance-avoidance and mastery-avoidance goals were negatively related to achievement. Table 1 provides a summary of their findings with regard to the relations among the four achievement goals and the two outcome variables.

Table 1

Achievement Goal Relations to Outcome Variables

	Performance-Approach goals	Performance-Avoidance goals	Mastery-Approach goals	Mastery-Avoidance goals
Help-Seeking	ns	$\boldsymbol{\rho}$ = -.21	$\boldsymbol{\rho}$ = .16	$\boldsymbol{\rho}$ = -.08
Performance	$\boldsymbol{\rho}$ = .13	$\boldsymbol{\rho}$ = -.18	$\boldsymbol{\rho}$ = .10	$\boldsymbol{\rho}$ = -.09

Note. Data from Baranik et al. (2010). Help-seeking included feedback-seeking from peers, instructors, or supervisors; feeling like a failure when needing help; avoidance of help-seeking; and asking for help to avoid or reduce work-related effort. Performance measures included GPAs and exam and task scores. “ns” indicates variables are unrelated.

Similarly, Burnette et al. (2013) employed meta-analytical procedures to generate a theoretical model to explain the relations between implicit beliefs about intelligence and achievement along three mediational pathways: (1) achievement goals, (2) use of mastery and helpless strategies, and (3) expectations and negative emotions. With respect to achievement goals serving as a mediator of the relations between implicit beliefs about intelligence and achievement, the authors found the more learners adhered to a growth mindset, the more likely they were to adopt mastery-oriented goals and the less likely they were to adopt performance-oriented goals. In line with Dweck (1999), neither paths from mastery goals nor performance goals to achievement were significant. Prior research has shown that learners' strategy use mediates the relationship between achievement goals and academic outcomes (Greene et al., 2004; Greene & Miller, 1996; Phan, 2010; Vrugt & Oort, 2008; Wolters, Yu, & Pintrich, 1996).

With regard to the path between incremental beliefs about intelligence and achievement goals, Burnette et al. (2013) also found that the strength of these predictions was moderated by whether learners' mastery or performance goals were oriented toward taking advantage of opportunities to pursue competence (approach) or avoiding the inability to achieve competence (avoidance). Specifically, Burnette and colleagues' analyses of 85 studies showed that incremental beliefs about intelligence shared a stronger positive association with mastery-approach goals than with mastery-avoidance goals. A similar pattern was evident in the association between intelligence beliefs and performance-oriented goals in that incremental beliefs had a significantly lower association with performance-avoidance goals than with performance-approach goals.

Other analyses showed that performance and mastery goals were not directly associated with achievement. The relationship between achievement goals and achievement was moderated by whether the achievement goals were approach- or avoidance-oriented. Specifically, the authors found that both performance-avoidance and mastery-avoidance goals were more strongly associated with poorer achievement than performance-approach and mastery-approach goals were positively related to achievement. Again, while a main effect was not observed, these findings indicate that avoidance goals may undermine achievement outcomes. In addition, these findings align with those of Baranik et al. (2010) indicating that while performance-approach and mastery-approach goals were positively associated with achievement, mastery-avoidance and performance-avoidance goals appeared to be detrimental to achievement.

The findings of these meta-analyses indicate that accounting for approach and avoidance valences is necessary, not only as they pertain to performance-oriented goals, but also as they pertain to mastery-oriented goals. Distinguishing achievement goals by their valence is essential to understanding the relations of implicit beliefs about intelligence and achievement goals as well as the consequential impact on academic behaviors and achievement (Burnette et al., 2013).

Given that incremental beliefs are associated with mastery-oriented competency pursuits (Blackwell et al., 2007; Dinger & Dickhauser, 2013; Dupeyrat & Mariné, 2005; Dweck, 1999, 2006), the researcher predicted that incremental beliefs would positively predict both mastery-approach and mastery-avoidance goals and negatively predict performance-avoidance goals. Additionally, given that entity beliefs are associated with performance-oriented competency pursuits (Dweck, 1999, 2006; Hong et al., 1999; King & McInerney, 2014), the researcher predicted that entity beliefs would positively predict performance-avoidance goals and negatively predict both mastery-approach and mastery-avoidance goals.

Some contemporary research findings contradict Dweck's (1999) finding regarding the relationship between implicit beliefs about intelligence and performance-approach goals (Dinger & Dickhauser, 2013; Dupeyrat & Mariné, 2005). These studies are more in line with Dweck and Leggett's (1988) findings that while mastery-oriented learners tend to hold incremental beliefs and performance-avoidance learners tend to hold entity beliefs, performance-approach learners tend to maintain either incremental or entity theories at relatively equal rates. Despite these inconsistencies, in the present research the researcher adhered to Dweck's (1999) premises in predicting that entity beliefs would positively predict performance-approach goals.

Achievement goals and academic achievement. According to Dweck (1999), the connection between implicit beliefs and achievement goals is important because when challenges arise, particular competency pursuits support or hinder learning by way of directing the strategic behaviors learners employ.

Inconsistent results have also been found about the connections between achievement goals and academic achievement (Hulleman, Schrager, Bodmann, & Harackiewicz, 2010). For instance, mastery goals are sometimes found to be positively related to academic performance (Church, Elliot, & Gable, 2001; Hulleman et al., 2010; Linnenbrink-Garcia, Tyson, & Pattal, 2008; Phan, 2010), but in other instances, they are observed as unrelated to achievement outcomes (Elliot & McGregor, 1999; Harackiewicz et al., 2002). As discussed above, one possible explanation for the inconsistencies observed in mastery goal outcomes is that most achievement motivation research does not account for the differences in mastery-approach goals and mastery-avoidance goals (Elliot & Murayama, 2008).

Inconsistent findings have also been observed about performance-oriented goals. Initially, performance goals were considered negatively related to achievement (Ames, 1992; Dweck & Leggett, 1988; Ranellucci, 2013). With the bifurcation of approach and avoidance goals, however, most of the deleterious effects of performance goals have been attributed to performance-avoidance goals while performance-approach goals have been found in most cases to be positively related to academic performance (Church et al., 2001; Hulleman et al., 2010; Linnenbrink-Garcia et al., 2008). Unexpectedly, in some cases, performance-approach goals have been even more predictive of grades than mastery goals (Elliot & McGregor, 1999; Harackiewicz et al., 2002; Phan, 2009b).

Another reason for the inconsistent findings pertaining to the nature of the relationship of mastery and performance goals to academic achievement may arise from differences in how achievement goals are measured (Elliot & Murayama, 2008; Hulleman et al., 2010). Specifically, Hulleman et al. (2010) found that differences in how goals were defined led to broad variations in assessment items that made it difficult to compare findings across studies. For instance, some measures of mastery goals were defined as attaining one's full potential (e.g., "I want to learn as much as possible from this class"), developing competence (e.g., "I do my work because I'm interested in it"), mastering challenges (e.g., "It is very important to me to feel that my coursework offers me real challenges"), and so forth (p. 427). A similar pattern was observed among performance goals. For instance, some of the measures of performance goals were defined as “the desire to prove one’s competence and gain favorable judgments about it” (e.g., “It’s important that others know that I am a good student”), “demonstrating competence” (e.g., “I like school work that lets me show how smart I am”), “demonstrating ability” (e.g., “I feel successful if I show people I’m smart”), and so on (p. 425).

The present research attended to inconsistencies in how achievement goals are measured by using Elliot and Murayama’s (2008) revised Achievement Goal Questionnaire (AGQ-Revised). The authors conceptualize achievement goals absent any of the underlying antecedent reasons for learners’ particular pursuits. In Elliot and Murayama’s (2008) instrument, each item focuses on the thoughts learners maintain that indicate their pursuit of or aversion to particular outcomes. Elliot and Murayama (2008) write that the “poor correspondence between how the goals are conceptualized and how they are operationalized […] makes it difficult to interpret empirical results straightforwardly and confidently, whether they are supportive or unsupportive of theoretical predictions” (p. 613).

A third contributing factor that may account for the lack of consistent findings on the relationship between academic goals and achievement may be the failure to account for the mediating role of strategic cognitive processes, such as reading comprehension strategy use, that transform achievement goals into desired academic outcomes (Bandura, 1986; Boekaerts, 1996, 1999; Horner & Shwery, 2002; Howell & Watson, 2007; Pintrich, 2000b; Winne, 1995; Zimmerman, 1990, 2000). For instance, using the trichotomous goal model, Ranellucci (2013) found evidence that learners’ achievement goals were predictive of the types of reading comprehension strategies they employed, which in turn contributed to their achievement outcomes on two comprehension tasks. The author used a think-aloud protocol to measure learners' use of deep-level comprehension strategies, including paraphrasing, elaboration, knowledge integration, and metacognition, as well as surface-level strategies, such as memorization and activation of prior knowledge before understanding the new information. The first comprehension task involved generating a written recall of the gist of two science passages about Newton's laws. The second comprehension task involved learners answering 14 multiple-choice questions that targeted common misconceptions about Newtonian laws.

The author found that the more college learners maintained mastery-oriented goals, the more likely they were to use deep and shallow text-processing strategies, which positively contributed to their success on both comprehension tasks. Also, the more often learners maintained performance-avoidance goals, the more likely they were to put off using deep-processing comprehension strategies, which negatively contributed to their performance on both achievement tasks. Finally, maintaining performance-approach goals was not predictive of deep or shallow comprehension strategy use, but it did have a direct negative impact on learners' achievement on the task assessing comprehension.

Similarly, using the trichotomous goal framework, Vrugt and Oort (2008) found that the maintenance of mastery goals among 952 beginning college learners positively predicted their self-reported use of deep cognitive and metacognitive strategies. The authors' findings regarding performance-oriented goals, however, differed substantially from the patterns observed by Ranellucci (2013). Performance-avoidance goals yielded no significant contributions to learners' use of metacognitive, deep-level, or surface-level processing, but the maintenance of performance-approach goals positively predicted learners' use of all three strategies. Surprisingly, only the use of metacognitive strategies made a significant positive contribution to learners' course exam scores; the positive contribution of deep cognitive strategy use to course exam scores was not significant. Finally, the use of surface-level strategies negatively contributed to course exam scores.

One possible explanation for the differences observed by Vrugt and Oort (2008) and Ranellucci (2013) is that Vrugt and Oort (2008) relied on learners' self-reports of strategy use, but Ranellucci (2013) engaged learners in a think-aloud protocol to measure their use of deep- and surface-level text-processing strategies. As discussed in the reading comprehension strategy use section below, the specific method of measuring strategy use impacts the ability to reliably interpret and compare research findings.

Despite the inconsistencies noted in the literature, several meta-analyses support the notion that mastery- and performance-approach goals are positively related to achievement outcomes, whereas mastery- and performance-avoidance goals are negatively related to achievement outcomes (Baranik et al., 2010; Burnette et al., 2013; Hulleman et al., 2010). Consequently, in the present research, it was anticipated that learners' maintenance of mastery-approach and performance-approach goals would be positively associated with achievement outcomes and that learners' maintenance of mastery-avoidance and performance-avoidance goals would be negatively associated with achievement outcomes. Also, in agreement with contemporary achievement motivation literature, this study predicted that learners' use of strategies would mediate these relations (Howell & Watson, 2007; Ranellucci, 2013; Vrugt & Oort, 2008). Learners' adherence to mastery-approach and performance-approach goals would be positively associated with the use of deep-level strategic reading comprehension processes and have a beneficial impact on achievement (Howell & Watson, 2007; Phan, 2009b; Vrugt & Oort, 2008). Also, learners' maintenance of mastery-avoidance and performance-avoidance goals would positively contribute to their use of surface-level strategies and negatively contribute to their use of deep-level strategic processes, which would have an adverse impact on achievement outcomes (Howell & Watson, 2007; Ranellucci, 2013).

As discussed above, psychological factors can be consequential for learning outcomes. Learners' beliefs about intelligence, judgments of their ability to succeed at undertaking specific tasks, and competency pursuits influence their strategic academic behaviors and subsequent learning outcomes. Moreover, psychological factors play a role in shaping learners' perceptions and responses to messages they receive in learning environments. The next section discusses the role of learning environments in supporting reading comprehension and academic achievement.

Learning Experiences

The second component of the social cognitive theory framework addresses learners' experiences in learning environments. Learners' experiences in academic environments play a major role in their achievement motivation, use of strategic academic behaviors, and subsequent achievement performances (Ames, 1992). Furthermore, it is within learning environments that learners receive feedback and messages that inform them of their academic successes and failures (Pintrich & Schunk, 2002).

For some beginning college learners, the unanticipated difficulties they experience while attempting to comprehend complex college-level texts can be baffling, particularly when they previously excelled with ease at completing academic reading tasks in high school (Haycock & Huang, 2001; Hughes, Karp, Fermin, & Bailey, 2005; Reid & Moore, 2008). Encountering unexpected academic challenges in college may lead learners who maintain unproductive beliefs about intelligence to disengage from their original academic goals and conclude that they are not smart enough to succeed in college (Haycock, Barth, Mitchell, & Wilkins, 1999).

One reason some beginning college learners may struggle with reading tasks in college despite having thrived in high school is the lack of congruity pertaining to required academic reading (Venezia, Kirst, & Antonio, 2003). Haycock et al. (1999) conducted a comparative review of select standardized exams used for high-school accountability measures and college admissions and placement decision-making. Examples of the standardized exams used as high-school accountability measures included the New York State Regents Exam, National Assessment of Educational Progress, and General Educational Development exam. Examples of the standardized exams used in college admissions and placement decision-making included COMPASS, ACT, SAT I, and SAT II.

The authors' analysis showed that in general, high-school reading assessments were aligned with high-school English language arts curricula and college entrance and placement reading exams included assessment items that extended beyond high-school curricula. Furthermore, the text on college entrance and placement reading assessments was more sophisticated and required higher levels of comprehension skill than the exams used in high schools. Finally, high-school exams tended to use short general interest stories or narrative texts, such as reading forms, instructions, and other types of day-to-day texts. Conversely, college entrance and placement exams tended to use more expository and literary texts, which are representative of the types of texts learners are required to comprehend in college courses.

Ultimately, the observed lack of congruity between high-school and beginning college reading tasks reveals that the stage has been set for some learners who have performed successfully in high school and on high-school assessments to enter college insufficiently prepared for comprehending complex college-level academic texts. This may cause some beginning college learners to struggle in their courses as they transition to college. Their struggle is likely to emerge as they experience the shift from reading tasks that require the use of surface-level comprehension skills to learning tasks that require sophisticated deep-level comprehension processing strategies.

Contemporary research supports the notion that the transition from high school to college presents a high degree of challenge for learners who are insufficiently prepared, particularly when they maintain unproductive beliefs about ability and low achievement motivation, and resort to counterproductive strategy use (Balduf, 2009; Boretz, 2012). For instance, Boretz (2012) found patterns of low achievement motivation and counterproductive strategy use when she sampled 100 students who, despite participating in an intervention program for first-year at-risk college students, were on the verge of academic dismissal. Compared to beginning college learners who had experienced academic success after participating in the intervention program, beginning college learners who were near academic dismissal were more likely to report they were less academically motivated to succeed, felt a lack of confidence in their abilities, and were unable to follow through despite wanting to do well. The author noted that these feelings were particularly true of learners whose high-school experiences had led them to believe that they were quick learners who could achieve high levels of academic success with little work or effort.

This pattern of unproductive beliefs, low motivation, and poor strategic choices was also observed in a small qualitative study of underachievement among first-year college students (Balduf, 2009). The author found that underachievers who had previously been high achievers in high school reported that their high-school experiences did not prepare them for the challenges they encountered in college. Underachievers felt they earned high grades in high school without working hard or expending much effort. Furthermore, although they took higher-level courses in high school, such as Advanced Placement, International Baccalaureate, and honors classes, most felt that they had never encountered challenges while completing their schoolwork.

The learners reported that when they experienced academic challenges in college, they lacked the strategic knowledge to respond effectively. Furthermore, they indicated that it was difficult to keep up with course readings on the syllabus because they procrastinated and lacked time-management skills. Beginning college learners also reported that they needed to improve their motivation, personal discipline, and effort to improve their academic circumstances. Finally, they perceived that interventions aimed at helping them improve their academic attitudes and strategic academic behaviors would be most useful for helping them overcome the challenges they were facing in college. These findings demonstrate that the transition between learning contexts that maintain discrepant performance standards can impact learners' achievement motivation, use of strategic academic behaviors, and ultimately, their academic success. This is true particularly when the demand placed on learners' performances increases dramatically.

First-year seminars. Many colleges have sought ways to ease beginning college learners' transition from the requirements of high school to the demands of college. Research suggests that the academic performance of beginning college learners can improve when they receive information and support from their academic communities that equips them to respond appropriately to the unanticipated challenges they encounter (Inkelas et al., 2007; Kuh, 2007; Porter & Swing, 2006; Zhao & Kuh, 2004). Although college programs that provide information and support to beginning college learners vary in format, first-year college experiences are among the most commonly employed support programs designed to meet the needs of beginning college learners as they transition to college life (Barefoot, Griffin, & Koch, 2012; Keup, 2005). These programs and/or courses are designed to provide first-year college students with information about institutional resources, peer support, and to varying degrees, academic skill and strategy instruction (Barefoot et al., 2012; Keup, 2005; Sparks & Malkus, 2013).

The present study focused on beginning college students in an AA program who were enrolled in a first-year seminar course that utilized an automated explicit reading comprehension strategy instructional program. The first-year seminar is a mandatory one-credit course that is graded on a pass/fail basis. Similar to traditional first-year course programs, one of the core goals of the course is to help first-year college learners cultivate academic skills for college success, including reading comprehension, studying, and time-management strategies. Providing an introduction to college-level expectations for learners' academic work is important for facilitating the transition from high school to the rigorous demands of college. When beginning college learners are underprepared for college-level work, particularly the demand that they comprehend large amounts of text, the result may be underachievement, evidenced by a mismatch between learners' attainable achievement and their actual performance (Balduf, 2009).

While providing beginning college learners with information and support to equip them for success during their transition to college is beneficial, some beginning college learners may need additional support that is targeted specifically toward helping them improve their processing of complex college-level texts.

Explicit reading comprehension strategy instruction. One way some colleges have attempted to attend to the difficulties that beginning college learners may experience in their attempts to comprehend complex college-level texts is to provide access to explicit reading comprehension strategy instruction. Numerous studies have shown that explicit reading comprehension strategy instruction can improve the comprehension performance of college learners who have low reading skills by honing their metacognitive awareness of impaired comprehension and increasing their use of deep-level comprehension processing strategies (Kurby, Macliano, Dandotkar, Woehrle, Gilliam, & McNamara, 2012; McNamara, 2004; O'Reilly, Sinclair, & McNamara, 2004).

It is possible that without explicit reading comprehension strategy instruction, some beginning college learners may not have access to knowledge about the comprehension standards for reading complex college-level texts or the strategies that are necessary for comprehension and academic success in college (Delpit, 2006; Gee, 2008). For instance, explicit instruction on reading comprehension and cognitive reading strategies can help learners establish appropriate standards for reading goals (e.g., at the situation model rather than the textbase), monitor their progress toward achieving established goals, and enact reading comprehension strategies that are aligned with their desired level of comprehension (Magliano, Todaro, Millis, Wiemer-Hastings, Kim, & McNamara, 2005; McNamara, 2009; Weinstein, Ridley, Dahl, & Weber, 1988).

The participants in the present study were enrolled in a first-year course that utilized a web-based automated reading tutor called iSTART (Interactive Strategy Training for Active Reading and Thinking) to improve beginning college learners' comprehension of college-level texts. iSTART is modeled after SERT (Self-Explanation Reading Training), a human-delivered explicit reading comprehension strategy instruction program that teaches learners how to utilize self-explanation and several reading comprehension strategies to improve comprehension of difficult texts (McNamara, Boonthum, Levinstein, & Millis, 2007). A detailed description of the iSTART training used in the participating first-year courses is provided in Appendix A. In the next section, a brief overview is provided.

The process of self-explanation involves readers actively explaining text as they read. According to the constructionist model of reading comprehension, the quality of learners' self-explanations or representations of the text is dependent upon their use of metacognitive and other reading comprehension processing strategies (Barth et al., 2015; Graesser, 2007). The primary goal of iSTART is to improve readers' self-explanations of challenging texts because many readers tend to focus on explaining texts in their own words or generating paraphrases while reading, which limits their comprehension to the textbase (Baker, 1985; Linderholm et al., 2014; Otero & Kintsch, 1992).

iSTART provides strategy instruction for deep-level reading comprehension processes that facilitate the construction of highly cohesive mental representations of the text at the situation model (Barth et al., 2015; Kendeou et al., 2014; McMaster et al., 2014; Oakhill et al., 2003; van den Broek et al., 2009). Specifically, iSTART focuses on teaching the following five reading comprehension strategies to improve learners' self-explanations of text: (1) comprehension monitoring; (2) paraphrasing; (3); bridging inferences; (4) elaboration, including the use of common sense and logic; and (5) predictions. Teaching these strategies is beneficial because prior research shows that they are essential, particularly when used in tandem, for deep-level comprehension of difficult text (Graesser, 2007; Kurby, Ozuru, & McNamara, 2007). iSTART teaches learners to use comprehension monitoring to actively maintain an awareness of their reading comprehension progress. Learners are also taught that when difficulties arise that impede comprehension, they should attempt to use the five reading comprehension strategies to ask questions and generate self-explanations to clarify ideas, explain and predict conceptual relationships, and summarize the text (Magliano et al., 1999; Palinscar & Brown, 1984; Snow, 2002). Table 2 provides a brief overview of the five reading comprehension strategies taught in iSTART and SERT for enhancing learners' self-explanations of difficult texts.

Table 2

Overview of the Reading Comprehension Strategies that Enhance Self-Explanation

Strategy	Description	Level of Text Representation Supported
Comprehension Monitoring	Continuously checking understanding of what is read while reading. When learners are aware that they lack understanding, they can respond by utilizing the self-explanation technique and other reading comprehension strategies.	**Situation model (deep-level):** Supports learners' ability to construct a complex and detailed representation of the text by initiating questioning and self-explanation processes
Paraphrasing	Restating the text of a single clause or proximate sentences in your own words	**Textbase (surface-level):** Supports local coherence because when used in self-explanations, text representation is limited to individual or adjoining clauses and sentences
Bridging	Connecting what has been read in one part of the text to other parts of the text	**Situation model (deep-level):** Supports learners' ability to construct a complex and detailed representation of the text because self-explanations connect ideas throughout the text
Elaboration	Connecting what is read in the text to prior topical, domain, or world knowledge	**Situation model (deep-level):** Supports learners' ability to construct a complex and detailed representation of the text because self-explanations incorporate prior knowledge
Prediction	Continuously thinking ahead about what the text might cover next. When learners are actively thinking about what they have read and anticipating what will come up next, it provides another means of monitoring their comprehension. If the new text is not in harmony with their understanding of what they have already read, learners can respond by utilizing the self-explanation technique and other reading comprehension strategies.	**Situation model (deep-level):** Supports learners' ability to construct a complex and detailed representation of the text because when used in self-explanations, it reflects prospective awareness of how ideas are connected throughout the text and/or to prior knowledge

According to social cognitive theory, learning environments can influence learners' achievement outcomes. Learning environments can be a source of support for beginning college learners who are struggling to comprehend complex college-level texts during their transition from high school to the rigorous demands of college-level work. Supportive learning environments can be used to provide beginning college learners with access to strategic knowledge to help them successfully navigate college requirements, specifically with regard to strategically responding to difficulties that emerge when trying to complete college-level reading tasks.

Reading Comprehension Strategy Use

The final component of the social cognitive theory framework addresses the influence of learners' academic behaviors on learning. With respect to the present study, academic behaviors represent learners' use of reading comprehension strategies. As previously discussed, reading comprehension processing strategies consist of the conscious cognitive efforts readers use to respond to difficulties they encounter while trying to comprehend text (Rapp et al., 2007). Although these processes are covert, reading research consistently indicates that the degree of proficiency with which readers use reading comprehension strategies influences the quality of their mental models of the text they read in terms of whether they are limited to the surface code or textbase or whether they attain situation model understanding of the text (Graesser, 2007; Magliano et al., 1999).

Representations of the text at the surface code indicate minimal comprehension of the text and that the reader is relying on surface-level strategies such as rote memorization to express his or her understanding of the text (Graesser et al., 1997; Magliano et al., 1999). Representations of the text at the textbase also indicate surface-level processing of the text. Readers use the paraphrasing reading comprehension strategy to restate in their own words individual ideas or concepts contained in one or more proximate sentences of the text (Haenggi & Perfetti, 1994; Kintsch, 1994). Representations of the text at the situation model indicate deep-level processing of the text and that the reader has a detailed understanding of the relationships between ideas and concepts throughout the entire text. Situation model understanding of the text is supported by learners' use of deep-level reading comprehension strategies such as bridging, elaboration, and/or prediction. The strategies are used to generate explanations of the text that connect multiple ideas throughout the entire text, connect ideas in the text to prior knowledge, and connect ideas in the text to prior knowledge to make predictions (Kintsch, 1994; Oakhill et al., 2003).

The following subsections discuss issues pertaining to readers' use of reading comprehension strategies. First, literature pertaining to the measurement of reading comprehension strategies is addressed. Second, the literature on the relations between reading comprehension strategy use and academic achievement is discussed. Finally, literature on the relations between reading comprehension strategy use and reading comprehension is addressed.

Measurement of reading comprehension strategy use. As discussed above, the way strategy use is measured may be consequential in terms of researchers' ability to reliably interpret and compare research findings. Contemporary achievement motivation theorists have raised concerns about how cognitive strategic processes are measured, pointing out that prior research has primarily relied on self-report inventories to capture learners' use of strategies (Winne, 2010). One concern is that learners may report using particular strategies because they are aware that "good learners" should use them. Another one is learners may believe that they use particular strategies when in reality they do not. A third concern is some learners may not realize they use particular strategies because they have automated their strategic processing and lack the awareness of what they typically do (Cromley & Azevedo, 2006; Veenman, 2005; Winne & Jamieson-Noel, 2002). Consequently, caution must be used when relying on learners' self-reports of cognitive strategy use because learners may exaggerate or underreport their strategy use, which may reduce the reliability of research findings.

For instance, Cromley and Azevedo (2006) administered three measures of reading strategy use to 30 ninth-grade learners to examine whether each measure correlated with two measures of reading comprehension. The following three measures of reading strategy were included: (1) a think-aloud protocol, (2) a multiple-choice strategy use measure, and (3) Mokhtari and Reichard's (2002) self-reported reading strategy use inventory. Procedurally, the first two measures of strategy use, the think-aloud protocol and multiple-choice strategy use measure, were administered concurrently as participants were in the process of reading. Conversely, the self-report measure was administered prospectively and reflected what learners believed they would do when endeavoring to complete reading tasks. The reading comprehension measures included a standardized 48-item multiple-choice reading assessment and a free-recall task that required learners to tell everything they remembered about the text read during the administration of the think-aloud protocol.

Cromley and Azevedo (2006) found that both concurrent measures of reading strategy use, specifically the rate of accuracy of learners' strategic processing during the think-aloud protocol and the scores earned on the multiple-choice strategy use assessment, were positively correlated with both the standardized and free-recall comprehension assessments. The self-reported strategy use inventory, however, was unrelated to learners' performances on the comprehension tasks. Concerns over the accuracy of learners' perceptions of their use of various reading comprehension and other strategies has prompted the emergence of creative methodologies for capturing learners' actual use of strategies as they engage in specific tasks.

In the literature on reading comprehension, there are two popular contemporary approaches for measuring learners' actual use of comprehension strategies: think-aloud protocols and trace methodologies (Winne, 2006, 2010). Think-aloud protocols are time-intensive in terms of research hours and are typically employed with a small number of participants. When working with large numbers of participants, however, trace methodologies are more efficient in terms of research hours and human resources expenditures.

Trace methodology involves tracking the evidence of learners' cognitive and metacognitive processes as they undertake particular tasks, including reading complex texts (Winne, 2010). Traces are the data learners generate as they execute particular cognitive or metacognitive processes. For instance, while metacognitively monitoring comprehension, a learner might make a note that a particular portion of text is confusing. Making the note generates a trace. Trace methodologies allow researchers to measure learners' natural and trained use of strategic processes without disrupting their flow (Winne, 2006, 2010).

While trace methodologies are effective for helping researchers avoid potential measurement bias created when participants misreport their actual strategy use, care must be given to ensure that trace methodologies are designed to capture appropriate trace evidence to support theoretical assumptions. For instance, although there is evidence that voluminous highlighting is associated with rote memorization and comprehension at the surface code (Nesbit et al., 2006), if voluminous highlighting is coupled with other strategic processes, then the frequency of highlighting may not be the appropriate trace to measure. For instance, if highlighting is coupled with annotations, then trace evidence of the qualitative features of the annotations made may also be an appropriate measure of learners' strategic processing of texts.

For example, Bernacki et al. (2012) used trace methodology to explore the relations between achievement goals, strategy use, and learning from text among 160 college learners. The researchers tracked learners' use of the highlighting, note-taking, glossary, link creator, and information panel features in nStudy, an Internet-based learning environment. The link creator allowed learners to generate hyperlinks to useful information they found on the Internet. The information panel tracked learners' movements and allowed them to review the web pages they visited, the marks they made on any web-based texts, and the hyperlinks they created. Hyperlinks helped learners access supplementary information and real-world examples to elaborate on a text as they read. Bernacki et al. (2012) found evidence using the trichotomous goal framework that particular achievement goals predicted certain strategic processing behaviors as learners engaged with a reading task in nStudy.

The authors found that although mastery-approach goals positively predicted and performance-avoidance goals negatively predicted the frequency of learners' seeking additional information about the text and note-taking, neither of these strategic behaviors contributed to comprehension at the textbase or situation model as theoretically hypothesized. Bernacki and colleagues (2012) also found that the two strategic processes that were not predicted by achievement goals did predict comprehension at the situation model. Highlighting made a negative contribution to comprehension at the situation model, but clicking on a checklist to monitor progress on learning goals made a positive contribution to situation model comprehension.

It is possible that Bernacki and colleagues (2012) did not observe the anticipated relations between achievement goals, strategy use, and comprehension because their trace methodology did not capture qualitative features of learners' strategy use that were impacted by learners' competency pursuits or influential for comprehension. For instance, consider this subset of their findings: (1) Mastery-approach goals positively predicted note-taking; (2) performance-avoidance goals negatively predicted note-taking; and (3) note-taking did not contribute to comprehension at the textbase or situation model. These findings indicate that the more learners embraced mastery-approach oriented goals, the more notes they took. Conversely, the more learners embraced performance-avoidance oriented goals, the fewer notes they took. The frequency of learners' note-taking, however, does not reveal the quality of the notes they made or how learners used the tool. It is possible that learners' notes reflected a hodge-podge of direct quotes, comprehension monitoring statements, restatements of text, elaborations that connected the text to prior knowledge, bridging inferences that connected ideas throughout the text, and predictions about what learners anticipated reading about next. In addition, learners' notes may also have included extraneous comments that were unrelated to their comprehension efforts, such as "This was interesting" or "Save to read later." Without discerning the qualitative differences in learners' strategic use of note-taking, it is difficult to ascertain how, if at all, note-taking is related to the level of comprehension readers achieve.

The constructionist model of reading comprehension provides a beneficial framework for qualitatively assessing learners' utterances and written statements about the text they are reading to ascertain their level of comprehension. Specifically, when learners are asked to self-explain a text as they read, the degree of their comprehension of the text is evident in the quality of the self-explanations they generate through reading comprehension strategies (Chi et al., 1994). At the surface code, self-explanations reflect rote memorization of the text. At the textbase, self-explanations consist of restatements of individual ideas or concepts contained in one or more proximate sentences. At the situation model, self-explanations use inferences to construct complex and detailed explanations of the text.

Similar to Bernacki et al's (2012) findings, the present study used trace methodology to measure learners' actual use of cognitive reading comprehension processing strategies that impacted textbase- and situation model-level comprehension. The present research gave special attention to measuring the qualitative features of learners' strategy use in accordance with the constructionist model of reading comprehension. Using highlighting as an example, Winne (2010) cautions that

> a highlighted section of text unambiguously marks that a learner discriminated the highlighted information from information not highlighted. But other information beyond trace data are needed to infer standards the learner used to monitor text and how decisions were reached to exercise metacognitive control in the form of highlighting versus some other action. (p. 272)

Consequently, this study employed the theoretical framework of the constructionist model of reading comprehension to examine the qualitative features of learners' use of reading comprehension strategies to generate self-explanations of the text (Alexander et al., 1994; Kendeou et al., 2014). Learners' generation of self-explanations were assessed to ascertain if they represented comprehension monitoring, surface-level comprehension processing in the form of paraphrases, or deep-level comprehension processing in the form of elaborative, predictive, or bridging inferences.

According to the constructionist model of reading comprehension, the technique of generating self-explanations prompts learners to seek out, integrate, and anticipate details within the text as well as from their prior knowledge to improve their comprehension (Graesser, 2007; Magliano et al., 1999; McNamara, 2004; Millis et al., 2004; Springer, 1985). The use of reading comprehension processing strategies can improve the quality of learners' self-explanations by helping them generate questions, clarify ideas, predict and explain conceptual relationships, and summarize the text. Using self-explaining and reading comprehension strategies supports text comprehension by helping learners integrate the information they garner from the text into their knowledge and to utilize known details to fill in conceptual gaps that are not attended to within the text (Linderholm et al., 2014; McNamara, Ozuru, Best, & O'Reilly, 2007). These qualitative features of learners' self-explanations are discernable and measurable.

Ozuru, Briner, Best, and McNamara (2010) found evidence among 78 undergraduates that discerning the qualitative features of learners' self-explanations significantly explained differences in reading comprehension. In their study, learners were asked to type a self-explanation of target sentences as portions of a text appeared on a computer screen. Learners were not trained in self-explanation; however, they were provided with an example of a good self-explanation that included ideas from multiple sentences of a sample text and made connections to prior knowledge. Afterwards, learners were asked to respond to nine open-ended questions that assessed comprehension at the textbase, local, and global or situation model levels. The authors describe local-level comprehension as the ability to synthesize ideas from two adjoining sentences in the text. Ozuru and colleagues' (2010) textbase- and local comprehension-level designations differ slightly from the constructionist model of reading comprehension. In the constructionist model, no distinction is made between textbase and local comprehension: they are considered collectively to represent textbase-level comprehension and to be indicative of local coherence (Haenggi & Perfetti, 1994;

Kendeou et al., 2014). Finally, learners also answered eight prior domain knowledge questions and completed a reading skill assessment.

Ozuru and colleagues (2010) employed a multilevel manual coding procedure to assess the quality of learners' self-explanations of the target sentences. First, learners' responses were assessed to determine if they included an accurate and relevant paraphrase of the target sentence. Qualifying responses were then assessed to determine if they included accurate and relevant features of the following elements: (a) near-bridging, which included the paraphrase and an inference based on the preceding sentence; (b) far-bridging, which included the paraphrase and an inference based on information presented in the text before the preceding sentence; (c) general knowledge, which included the paraphrase and an inference based on general or personal knowledge; and (d) domain knowledge, which included the paraphrase and an inference based on prior topical or domain knowledge. Using their coding system, an accurate and relevant paraphrase would be the lowest-quality self-explanation possible. The highest-quality self-explanation would make connections between the details of an accurate and relevant paraphrase and accurate and relevant details in (1) an adjoining sentence, (2) a distant sentence, (3) learners' general or personal knowledge, and (4) learners' prior domain knowledge.

The researchers examined learners' performance on the comprehension tasks as a function of the quality of their self-explanations. Ozuru and colleagues (2010) found that the quality of learners' self-explanations was positively related to their performance on textbase, local, and situation model questions. Learners' comprehension performances on each question type (i.e., textbase, local, and situation models) and their random assignment to read a low or high local coherence text was analyzed using hierarchical linear regression. Local coherence refers to the degree of connectivity and relatedness within a text from one sentence to the next (Beck, McKeown, Sinatra, & Loxterman, 1991). The authors derived the low-cohesion text from a college text. To create the high-cohesion text, the researchers made substantial additions to the low-coherence text to "decrease the extent to which readers needed to make inferences to maintain local coherence" (Beck et al., 1991, p. 648).

The results of their analyses indicated a main effect on all models for the quality of self-explanations. This indicates that the overall quality of the self-explanations learners generated significantly influenced their comprehension scores at the textbase, local, and situation models. Learners' assignment to the low-cohesion text group also made a significant positive impact on comprehension at the textbase, which resulted in an interaction effect.

The significance of Ozuru and colleagues' study (2010) is that by using a coding system that took into account the varying degrees of complexity in learners' processing of texts, as evidenced by the number and range of qualitative features learners used to generate self-explanations, the researchers were able to tap into strategic processes that significantly explained learners' comprehension at the textbase, local, and situation model levels. Learners who effortfully engaged in generating detailed self-explanations of the text by using multiple deep-level reading comprehension strategies in tandem achieved higher levels of text comprehension than those who conservatively used deep-level reading comprehension strategies and relied more heavily on the use of surface-level strategies. Furthermore, the analyses showed that the effects of the quality of self-explanations was over and beyond any differences in learners' reading skill and prior domain knowledge.

Similar to Ozuru et al. (2010), the present research assessed the quality of learners' self-explanations of target sentences utilizing a similar coding procedure. In the present research, learners' self-explanations were coded to reflect their inclusion of reading comprehension strategies, specifically the use of bridging, elaborative, and predictive inferences, as well as paraphrasing and comprehension monitoring.

The next section discusses the literature regarding reading comprehension strategy use and academic achievement.

Reading comprehension strategy use and academic achievement. Few studies have examined the relations between college learners' strategic reading comprehension processes and general academic outcomes, such as their GPAs. There is some evidence, however, that a positive relationship exists between the use of reading comprehension processing strategies and academic achievement (Pintrich, Smith, Garcia, & McKeachie, 1991, 1993; Taraban, Rynearson, & Kerr, 2000). For instance, in a study of the relations between college learners' knowledge and use of reading comprehension strategies to GPA, Taraban et al. (2000) found evidence that learners who earned higher GPAs demonstrated more knowledge of reading goals and strategies than learners with lower GPAs. The authors requested 324 undergraduates enrolled in psychology courses to respond to two open-ended items. The first item asked learners to list various goals one might have for reading. The second item asked learners to list things they could do when they experienced difficulty comprehending texts. Afterwards, participants were asked to complete a 35-item reading strategy use inventory. Sample items on the inventory included, “I read material more than once in order to remember the text,” “I summarize/paraphrase the material that I am reading in order to remember the text,” and “After I have read a text, I try to interpret what I have read” (Taraban et al., 2000, pp. 307-08).

Using median splits to distinguish between learners with high and low GPAs, the researchers found that on average, learners with high GPAs reported significantly greater use of 31 of the 35 reading comprehension strategies on the inventory than learners with low GPAs. Unfortunately, the researchers did not provide information as to whether these strategies corresponded to surface- or deep-level reading comprehension processing strategies. The researchers also investigated the distribution of strategies learners recalled for responding to difficulties that arise while reading. Specifically, on the open-ended measure, the researchers reported that most learners recalled surface-level processing strategies for attending to comprehension difficulties, such as rereading (52%), looking up unknown vocabulary (45%), and asking for help (45%). Conversely, few learners recalled deep-level processing strategies, such as activating prior knowledge (7%), generating questions (6%), and making inferences (2%). The researchers did not report whether there were differences in the types of strategies high- or low-GPA learners recalled. In general, however, these results mirror the findings of other research, including Linderholm et al. (2014) and McNamara (2004), in suggesting that college learners are partial to using strategies that require less time and less deliberate and conscious efforts.

Although this research was correlational, its findings are noteworthy in that it provides some evidence of a connection between learners' overall academic achievement and their awareness and self-reported use of metacognitive and cognitive reading comprehension strategies. In addition, it supports the notion that college learners may be drawn to using surface-level strategies rather than deep-level reading comprehension processing strategies, even when they are confronted with impediments that hinder their comprehension of texts. It is likely that learners' attempts to comprehend complex college-level texts will be unsuccessful if they rely solely on surface-level reading comprehension strategies that limit comprehension to the surface code or textbase. The next section discusses literature pertaining to reading comprehension strategy use and reading comprehension.

Reading comprehension strategy use and reading comprehension. Learners' proficient use of reading comprehension strategies is important for supporting their ability to learn from complex texts. For instance, in the first of two studies, Linderholm et al. (2014) examined the strategic processes 26 undergraduate learners used to comprehend multiple science texts to determine which, if any, were related to two measures of text comprehension. Learners' comprehension of the texts at the textbase was assessed on a multiple-choice test, and a writing task requiring integration of ideas across three texts was used to assess comprehension at the situation model. Learners' comprehension processes were investigated by way of a think-aloud protocol that required learners to speak their thoughts out loud after reading each sentence of the target texts.

The authors identified 15 categories of cognitive strategies that learners utilized during the think-aloud protocol, including the five self-explanation strategies taught in iSTART, including comprehension monitoring, paraphrasing, bridging and elaborative inferences, and prediction inferences. The researchers found that the cognitive processes uttered most often among the learners involved both metacognitive monitoring of comprehension and self-explanations of the texts. Specifically, learners regularly uttered self-explanations to make connections to previously read portions of the text in use and to incorporate other information they knew. This reflects the use of bridging and elaborative inferences, respectively. Learners also regularly used metacognitive comprehension monitoring to generate expressions of the status of their understanding of text.

Learners' use of bridging and elaborative inferences was positively related to their performances on both the 20-item multiple-choice reading comprehension and writing task assessments. The more bridging and elaborative inferences learners generated during the think-aloud procedure, the more sentences they produced on the writing task, and the higher they scored on the reading comprehension test and written task. These findings align with the theoretical expectations of the constructionist model of reading comprehension, which posits that learners' generation of bridging and elaborative inferences supports deep-level comprehension at the situation model. Furthermore, the more self-explanations learners generated during the think-aloud protocol, the more self-explanations they included in their written products. This included sentences with paraphrases, bridging inferences of information from two or more texts, and elaborative inferences that connected the texts to their own knowledge. These findings support the notion that the types of self-explanations learners generate as they read text are related to their subsequent comprehension of the text, not only at the textbase, but at the situation model as well.

Linderholm et al.'s (2014) findings indicate that the process of using reading comprehension strategies to generate self-explanations aids in learners' ability to integrate ideas and concepts presented in texts as well as their subsequent comprehension of texts. Interestingly, however, the authors also found that for the writing task, considerably more surface-level reading comprehension strategies, specifically paraphrasing of sentences, were constructed (77%) than deep-level elaborative or bridging inference sentences (14%), despite paraphrases lacking the level of strategic processing sophistication necessary to integrate ideas from multiple texts. According to Graesser (2007), successful readers' use of sophisticated comprehension strategies is "deliberate, conscious, effortful [and] time-consuming" (p. 4). Linderholm et al.'s (2014) findings lend credence to the notion that since successful comprehension strategies come at a cost in terms of effort and time, many readers tend to rely on surface-level strategies that preclude in-depth understanding of texts (Baker, 1985; Otero & Kintsch, 1992). Specific to Linderholm et al.'s (2014) study, many readers settled for surface-level comprehension rather than deep-level comprehension. Deep-level comprehension strategies are crucial for collegiate success, however, because they enable the generation of inferences that lead to global comprehension of complex texts (McNamara et al., 2007).

With regard to metacognitive strategic processing, Linderholm et al. (2014) observed an inverse relationship between learners' superficial expressions of understanding and their performance on the writing task. The more often learners made vague statements to express that they understood what they read and the more they expressed that they were experiencing problems comprehending the text, the fewer paraphrases, bridging inferences, and connections they made within the text to prior knowledge and across multiple texts, respectively. The more they explicitly expressed understanding of the text, however, the more bridging and elaborative inferences they were able to make. These results are consistent with other research that has examined the role of metacognition in reading processes. Specifically, if readers can accurately assess their comprehension status, they can make better decisions about how to repair the gaps in their comprehension and improve their performance on comprehension tasks. Conversely, if learners are unable to accurately assess their understanding of text, particularly when they encounter problems while reading, their ability to diagnose and fix problems will be suppressed and their comprehension will be hindered (Glenberg & Epstein, 1985; Maki, 1998; Underwood, 1997).

Linderholm et al. (2014) expanded upon their first study by increasing the number of participants (N = 118 undergraduates enrolled in an educational psychology course), excluding the think-aloud protocol, and including ten short-essay comprehension questions about novel concepts and common misconceptions pertaining to the target text.

Learners were divided into two groups. The control group was given generic pre-reading instructions to read the texts for comprehension. In contrast, the intervention group was instructed to explain the text to themselves as they read the text. Independent raters blind to the treatment condition assessed the essays.

The authors found that readers who were told to use self-explanation while reading significantly outperformed their peers in the control group. Specifically, the self-explanation group provided more explicit, complete, and accurate descriptions of circuitry processes. In addition, learners who used the self-explanation technique demonstrated greater accuracy than the control group on questions designed to capture common misconceptions about electricity. Linderholm and colleagues' (2014) study, along with other literature (Trabasso & Migliano, 1996), supports the notion that self-explaining is a natural part of comprehension processing since learners who self-explained outperformed their peers on the comprehension tasks by merely receiving a metacognitive nudge to enact the self-explanation technique as they read. Given that learners can instinctively engage in self-explanation, as evidenced by learners in the intervention group, it is possible that if beginning college learners are given explicit strategy instruction on how to enhance this technique by incorporating the use of deep-level reading comprehension strategies, they may readily adopt regular and independent use of the self-explanation technique and reading comprehension strategies to improve their comprehension when confronted with difficult texts.

Reading comprehension strategy use and explicit reading comprehension strategy instruction. Research suggests that college learners who have low reading skills can be taught reading comprehension strategies and how to use them appropriately to improve their comprehension of complex college-level texts (Gruenbaum, 2012; Kurby et al., 2012). McNamara (2004) provides evidence that explicit reading strategy instructional interventions can have a positive impact on readers' subsequent reading strategy use and comprehension of difficult texts. The author collected data on 42 undergraduate biology and psychology majors' reading ability and comprehension of biology texts. Half of the participants received Self-Explanation Reading Training (SERT), coupled with four practice texts and comprehension checks over four sessions. The other participants in the control group read the practice texts aloud and answered the same comprehension questions as the SERT group during their four practice sessions. The control group, however, did not receive self-explanation strategy instruction.

After the SERT intervention was administered, McNamara (2004) presented learners with the final comprehension assessment, which entailed both groups using self-explanations to answer ten questions about a biology text. Five questions were textbase-level questions requiring learners to recall the text and at a minimum generate paraphrases. The other five questions were at the situation model level and required learners to connect ideas from two or more sentences throughout the text and at a minimum generate bridging inferences. Finally, learners were asked open-ended questions that extended beyond the information presented in the text to assess prior topical knowledge. Responding to these questions required learners to, at a minimum, generate accurate elaborative inferences.

McNamara (2004) found that readers in the self-explanation training group answered more textbase and situation model bridging comprehension questions accurately than control group readers who engaged in the four read-aloud sessions during the four practice sessions. Analysis of variance on post-training comprehension scores also showed that the training condition (SERT versus the control group) and prior knowledge (low- versus high-domain knowledge) had a significant effect on comprehension at the textbase and situation model. First, high-knowledge learners outperformed low-knowledge learners on both comprehension tasks in both SERT and the control group. Second, learners with low-domain knowledge in the SERT condition significantly outperformed learners with low-domain knowledge in the control group on textbase comprehension questions but not on situation model comprehension questions. This indicates that training on the use of the self-explanation technique and reading comprehension strategies may be particularly useful for low-knowledge learners in terms of icreasing comprehension of complex texts. The training condition, however, had no significant impact on high-domain knowledge learners' comprehension performances at the textbase or situation model.

The author also analyzed the utterances of 26 participants' self-explanations. Results showed that learners' generation of accurate bridging and elaborative inferences and their self-explanation scores were positively related to scores on the textbase and situation model bridging comprehension questions. The self-explanation score was calculated by summing the number of self-explanations learners generated using comprehension strategies that went beyond the text, specifically the use of predictions, elaborations, and comprehension monitoring. Analysis of variance revealed two main effects. First, learners in the SERT condition generated higher self-explanation scores than learners in the control group. Second, learners with high prior knowledge generated higher self-explanation scores than learners with low prior knowledge. There was no interaction effect. Finally, regression analysis showed that learners' self-explanation scores positively predicted comprehension scores at the Textbase, as well as at the situation model. These findings indicate that one of the primary benefits of teaching self-explanation and the five reading comprehension strategies in SERT is to help low-domain knowledge learners use deep-level comprehension processing strategies to make use of the information that they do know to comprehend complex texts. It appears that learners with low prior knowledge experienced difficulty generating bridging inferences to connect ideas throughout the text; however, through self-explanation and reading comprehension strategy training, they were able to access the text by using their general world knowledge.

O'Reilly et al. (2004) also found evidence that providing reading comprehension strategy instruction for reading complex texts can be beneficial for low-domain knowledge learners in college. In their research, strategy instruction was provided by way of both live and automated instructional platforms. The authors examined the comprehension performances of 297 college learners who were assigned to either (a) SERT, (b) iSTART, or (c) the control condition. The instruction provided in iSTART is equivalent to the training provided in SERT (discussed above), which includes all the components of explicit instruction, including an introduction to the SERT strategies, a demonstration of how the strategies are used, and guided and independent practice applying the strategies. During SERT and iSTART, independent practice consisted of learners using self-explanation as they read a text about thunderstorms and answered related comprehension questions. In the SERT condition, learners took turns self-explaining with a peer. In iSTART, learners self-explained by typing their explanations of each sentence into the iSTART automated platform. In lieu of training, learners in the control group were asked to independently read a passage on thunderstorms and self-report the strategies they used to aid their comprehension of the text and answer comprehension questions.

Pre-testing included assessments of learners' reading ability on a standardized reading measure and prior general knowledge of science and the humanities on a multiple-choice exam. One week after the two-hour reading strategy intervention, all participants were asked to read a passage on cell mitosis and to use the strategies they had discussed the previous week. Participants' comprehension of the text was assessed by six open-ended textbase questions that could be answered by paraphrasing a single sentence and six open-ended situation model questions that required learners to draw upon multiple sentences to generate bridging inferences. After completing the comprehension tasks, learners were asked to self-report the reading comprehension strategies they used to aid their understanding of the text.

Compared to learners in the control group, learners in the SERT and iSTART conditions reported greater use of deep-level processing strategies, such as bridging, drawing on prior knowledge, elaboration, prediction, self-explanation, and paraphrasing.

Compared to learners in the intervention conditions, learners in the control condition reported greater reliance on surface-level strategies, such as rereading, repetition, using mnemonics, or using no strategy at all.

The researchers also found that six self-reported reading comprehension strategies were positively related to learners' overall comprehension scores, specifically self-explanation, elaboration, bridging, paraphrasing, predictions, and rereading to understand. Caution must be exercised, however, when interpreting these findings because as discussed previously, learners' self-reports of strategy use are not always reflective of their actual strategy use (Winne, 2010). Furthermore, since learners' actual strategy use was not measured, it is uncertain to what extent learners in the intervention groups actually used the strategies they were taught.

Finally, O'Reilly and colleagues (2004) also found that learners in all three conditions answered more questions demonstrating comprehension at the textbase correctly than questions demonstrating comprehension at the situation model. Learners in the two intervention conditions outperformed learners in the control condition on total comprehension score, but most of the variance in participants' scores was explained by the scores earned on textbase questions that required restating a single sentence or idea from the text. There was no significant difference in the performance of learners in the intervention or control groups on situation model questions that required the integration of multiple ideas throughout the text. Similar to McNamara (2004), these data may reflect the difficulty learners have generating bridging inferences to connect ideas across the text, particularly when they possess limited domain knowledge.

One question that has emerged is as follows: Why do college learners rely heavily on surface-level rather than deep-level reading comprehension strategies for reading complex college-level texts, even after they have received explicit reading comprehension strategy instruction? One possible explanation for college learners' heavy reliance on surface-level comprehension strategies, even after receiving explicit reading comprehension strategy instruction (McNamara, 2004; O'Reilly et al., 2004), is that college learners are not motivated to expend the necessary time and effort to generate bridging inferences, particularly when they lack specific domain knowledge to help them readily identify the connections between ideas dispersed throughout texts. Specifically, the lack of distinction between intervention and control groups' performances on situation model-level questions are in line with other literature that shows some college learners avoid using deep-level comprehension strategies that are costly in terms of time and effort (Linderholm et al., 2014; Tartan, Rynearson, & Kerr, 2000). Furthermore, Perfetti, Landi, & Oakhill (2004) posit that readers conservatively utilize inference strategies because employing them requires the redirection of cognitive resources from the basic reading task. Consequently, beginning college learners may rely on surface-level comprehension strategies because they are quicker and simpler to execute.

The literature indicates that although providing reading comprehension strategy instruction can improve learners' comprehension of texts, college learners are resistant to using deep-level comprehension strategies even when they have been instructed on the use of these strategies. One way to attend to this conundrum may be to provide a brief social-psychological intervention that manipulates learners' ability beliefs. In the next section, the literature on social-psychological interventions is discussed. It is possible that employing a social-psychological intervention may support beginning college learners' use of the deep-level reading comprehension strategies taught in iSTART.

Growth-Mindset Interventions

Contemporary research in social psychology suggests that making use of a small and brief social-psychological intervention may encourage learners to expend the additional time and effort resources necessary to use all the deep-level reading comprehension strategies taught in iSTART, particularly the strategy of bridging ideas and concepts located throughout texts (Yeager & Walton, 2011). Specifically, in addition to providing access to deep-level reading comprehension strategy instruction, it may be gainful to alter beginning college learners' academic mindsets to promote the adoption of beneficial intelligence and motivational beliefs and encourage greater use of deep-level strategic processes. Manipulating learners' mindset may be necessary because prior research shows that underprepared learners' underachievement may be influenced by unproductive beliefs about intelligence and ability, low self-efficacy beliefs, and the use of counterproductive strategic academic behaviors (Mealey, 1990; Reis & McCoach, 2000). As evidenced in Wood and Bandura (1989), encouraging a growth mindset can bolster learners' strategic processing efforts to succeed when confronted with challenging tasks. Furthermore, the growth-mindset emphasis on the malleability of intelligence coupled with strategic effort may lead beginning college learners to intensify their efforts on mastering the use of deep-level reading comprehension strategies (Dweck, 1999, 2006; Dweck & Molden, 2005).

Blackwell et al. (2007) found evidence that providing a social-psychological intervention along with strategy instruction resulted in higher learning outcomes for participating learners compared to those who only received strategy instruction. In their study of 91 low-achieving seventh-grade students who were beginning junior high school, teaching a growth mindset in addition to providing instruction on time management and study skills made a positive impact on learners' math grades over the course of the academic year. The researchers compared learners' prior math grades at the close of the sixth grade with pre-intervention grades at the end of the fall semester in seventh grade and post-intervention at the end of the seventh-grade spring semester. All participants received strategy instruction in study skills and time management, but students in the growth-mindset intervention group were also taught that the brain is like a muscle, learning improves the brain, and people are in control of how strong their brain becomes and how much their brain grows. The control group received instruction on memory and participated in discussions about academic issues and concerns.

Blackwell and colleagues (2007) found that the intervention was successful such that students who were taught about the malleability of the brain endorsed stronger incremental beliefs about intelligence after the intervention was completed, while students in the control group remained unchanged with regard to their initial intelligence beliefs. In math achievement, the researchers found that learners who received the growth-mindset intervention along with strategy instruction experienced an abrupt shift in the trend of their math performance. While in general all the participants experienced a decline in their math performance from the close of sixth grade to the end of the fall semester of seventh grade, after the intervention, the growth-mindset group performed significantly higher in math and changed the trajectory of their achievement path to an upward trend. Conversely, students in the control group continued to experience a decline in math performance during the spring semester of seventh grade. Although these findings do not pertain to college students, they do suggest that social-psychological interventions may enhance the effects of strategy instruction and provide learners with a psychological boost that motivates them to earnestly use the strategies they are taught.

Helping learners adopt incremental beliefs about intelligence may encourage beginning college learners to invest the effort and time necessary to use deep-level reading comprehension processes such as elaboration, prediction, and bridging inferences in response to the comprehension difficulties. Specifically, research indicates that learners with incremental beliefs or growth mindsets are likely to maintain high self-efficacy beliefs (Wood & Bandura, 1989) and mastery-oriented achievement goals (Dinger & Dickhauser, 2013). Both motivational factors have been shown to positively contribute to strategic reading comprehension processing and achievement outcomes among college learners (Ranellucci, 2013; Vrugt & Oort, 2008). Accordingly, the present research tested whether teaching an academic growth mindset contributed to beginning college learners' adoption of adaptive motivational beliefs, use of deep-level comprehension processing strategies, and academic achievement.

The literature on growth-mindset interventions among college learners is limited. In one study, researchers taught 24 college learners to develop implicit theories about intelligence toward incremental or entity beliefs by providing instructional prompts for completing an 18-week organizational management simulation (Wood & Bandura, 1989). The researchers began the study by providing learners with weekly tasks and setting unachievable performance standards, thus creating a challenging learning environment. The researchers told learners in the incremental treatment condition that the purpose of the simulation was to provide practice that would help them develop and improve their organizational management decision-making skills. Learners in the entity treatment condition were told that the ability to make good decisions was indicative of cognitive ability and that the simulation would gauge their underlying cognitive abilities.

Although Wood and Bandura (1989) did not conduct a manipulation check, their findings indicate that the instructional prompts did impact the way learners responded to the challenging simulated environment. Specifically, over time the experience of repeated failure impacted each group differently in terms of their perceived self-efficacy, strategic decision-making, and task-performance outcomes. In terms of self-efficacy, learners in the incremental treatment group displayed greater resilience in response to challenges and failure than learners in the entity treatment group. The incremental group maintained high self-efficacy beliefs, while the entity group experienced a significant decline in self-efficacy. The incremental group also maintained a high degree of strategic processing and performance on simulation tasks, while over time, the entity group's strategic behavior became erratic and their performance declined.

Hong et al. (1999) also found evidence that college learners' implicit beliefs about intelligence could be manipulated to impact their academic behavior in response to experiencing failure. The authors randomly manipulated the implicit beliefs about intelligence of 60 undergraduates attending a university in Hong Kong by having the learners read an entity or incremental theory article. The authors verified learners' comprehension of the manipulation by asking participants to summarize the article in one sentence and describe the evidence they found most convincing. Learners were told that the manipulation was an English reading comprehension task. Similar to Wood and Bandura (1989), however, the authors did not conduct a true manipulation check.

After completing the manipulation writing task, learners were given five minutes to answer 12 of the most difficult problems on an intelligence test as "practice" that would familiarize them with the format of an upcoming exam. Learners were also instructed to leave no questions unanswered. The difficulty of the exam and the pressure to provide an answer for all questions within five minutes reduced learners' ability to self-assess their performance. After taking the practice exam, half of the participants received "satisfactory performance" feedback, indicating that they did well (i.e., they had answered seven questions correctly and scored at the 66th percentile of university undergraduates), but there was room for improvement. The remaining participants received "unsatisfactory performance" feedback, indicating they had answered three questions correctly and scored at the 20th percentile. Finally, while the experimenter prepared for the next task, participants were given the opportunity to work on either a tutorial that had been effective in improving learners' test performances or on an unrelated ability task.

Hong et al. (1999) found that the manipulation was successful and that it impacted learners' academic behaviors in response to performance feedback. Specifically, learners in both the incremental and entity treatment conditions responded with similar academic behavior when they received positive feedback regarding their academic performance on the practice exam (i.e., satisfactory performance). The majority of participants in both treatment groups (i.e., 67% of the entity treatment learners and 73% of the incremental treatment learners) opted to participate in the tutorial exercise in order to improve their future exam performances.

Conversely, negative feedback regarding their academic performance (i.e., unsatisfactory performance) had a differential impact on the way learners responded to the challenging task. For both feedback conditions, those who read an incremental theory article seemed to believe that the tutorial would be beneficial for improving their future performances on challenging tasks. When the majority of participants who read the incremental article received negative feedback, they opted to participate in the tutorial exercise at the same rate as their incremental treatment group peers who had received positive feedback (i.e., 11 of the 15 participants, or 73%).

The adaptive behavior observed among those who were primed with information about incremental beliefs was not evident among those with a fixed mindset. For these learners, receiving negative feedback on the challenging task was adversely consequential. Whereas the majority of their peers with fixed mindsets who had received positive feedback chose to work on the tutorial, the majority of their peers who had a fixed mindset (i.e., 13 of the 15 participants, or 87%) and received negative performance feedback decided to forgo the tutorial in favor of working on an unrelated ability task.

Only two (13%) of those who received feedback elected to work on the tutorial in hopes of improving their future performances on the challenging task.

Paunesku et al. (2015) conducted a study with high school learners to examine whether helping learners adopt a growth mindset would have a positive impact on academic achievement. In the study, 1,594 learners attending 13 geographically diverse high schools were randomly assigned to one of four conditions: growth mindset, sense of purpose, growth mindset and sense of purpose, or control. Although three interventions were administered, this discussion focuses primarily on the growth-mindset intervention. In addition to their primary analyses, the authors also examined the impact of the intervention on the spring semester grades of participants who were at risk of dropping out of high school (post-intervention). At-risk learners included participants who had failed one or more core courses (i.e., English, math, science, and social studies) or had earned a GPA of 2.0 ("C") or less in the fall semester (pre-intervention).

The 45-minute electronically administered growth-mindset intervention entailed learners reading an article. The article discussed the impact of hard work and strategic effort on the malleability of the brain. Participants in the control group read an article about the brain's functions without references to its malleability. Afterwards, participants were asked to summarize the article they had read and use what they learned to offer advice to a struggling learner. The authors conducted a manipulation check with pre- and post-intervention measures of entity beliefs about intelligence. Results showed that participants who had been taught the growth mindset held more malleable beliefs about intelligence than learners in the control/sense of purpose and combined intervention groups.

The growth-mindset intervention was successful in terms of positively impacting learners' achievement. Prior to the intervention, learners in the growth-mindset treatment and control groups were similar in terms of GPA. After the intervention, however, learners who were taught the growth mindset earned significantly higher grades than their control-group peers. Furthermore, regression analysis showed that the growth-mindset intervention was particularly beneficial for at-risk learners. Specifically, the mean change in learners' GPAs was greater for at-risk learners than learners who were not at risk for dropping out of high school.

Similar to Paunesku et al.'s (2015) study, the present study utilized scientific articles to inform learners in the growth-mindset treatment condition about the malleability of the brain. Learners in the control group read a generic article about brain development during late adolescence. Other studies have also used "scientific" articles to successfully prime growth mindsets (Aronson et al., 2002; Blackwell et al., 2007; Good, Aronson, & Inzlicht, 2003).

The literature on the impact of growth-mindset interventions on academic achievement overwhelmingly suggests that priming growth-oriented beliefs can be beneficial, particularly when learners must contend with challenging tasks (Hong et al., 1999; Paunesku et al., 2015; Wood & Bandura, 1989). Hong et al. (1999) also found that priming implicit beliefs about intelligence can impact learners' academic responses to failure. Consequently, if learners are primed to adopt a growth mindset about intelligence, they may be willing to invest the time and effort necessary to use the deep-level reading comprehension strategies they were taught when they are faced with learning from complex college-level texts.

The Current Study

Research evidence on implicit intelligence beliefs suggests that maintaining particular beliefs about the nature of intelligence influences learners' self-efficacy beliefs when challenging situations arise and is consequential to the pattern of achievement goals learners pursue (Burnette et al., 2013; Wood & Bandura, 1989). In addition, learners' confidence in their ability to successfully respond to learning challenges, as well as the patterns of achievement goals learners pursue, are likely to influence their use of strategies to overcome challenges (Baranik et al., 2010; Howell & Watson, 2007; Wood & Bandura, 1989). Furthermore, the use of reading comprehension strategies while reading influences college learners' comprehension of complex texts (Linderholm et al., 2014; Ozuru et al., 2010) and academic achievement (Taraban et al., 2000).

Reading comprehension research has also shown that even when explicit strategy instruction is provided, many college learners still struggle to use deep-level comprehension processing strategies (McNamara, 2004; O'Reilly et al., 2004). Research on social-psychological interventions in other academic domains has demonstrated that when learners were taught a growth mindset, they were able to reap greater benefits from strategy instruction than learners who did not receive the growth-mindset intervention (Blackwell et al., 2007).

Drawing on these findings, this study examined if teaching a growth-mindset supports the adoption of beneficial intelligence and motivational beliefs, increased use of deep-level reading comprehension strategies, and improved academic performance among students. Research shows that social-psychological interventions, such as growth mindset interventions, can have an impact on academic outcomes because the interventions target motivational and cognitive processes that contribute to academic performance (Yeager & Walter, 2011). Accordingly, this study investigated whether growth mindsets (versus fixed mindsets) are related to beginning college learners' reading comprehension strategy use and reading outcomes, and whether this relation is mediated through their motivational beliefs (i.e., achievement goals and self-efficacy).

This research explored the following three research questions:

1. Do motivational beliefs mediate the relationship between implicit theories of intelligence and reading comprehension strategy use?

2. Does reading comprehension strategy use mediate the relationship between motivational beliefs and achievement outcomes?

3. Does a growth-mindset intervention influence learners' endorsement of implicit intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes?

Based on prior research pertaining to the constructionist model of reading comprehension and the social cognitive theory framework, the following hypotheses are predicted for the first research question:

1. Mastery-approach goals will mediate the positive relationship between incremental beliefs about intelligence and reading comprehension strategy use.

2. Mastery-avoidance goals will mediate the positive relationship between incremental beliefs about intelligence and reading comprehension strategy use.

3. Performance-avoidance goals will mediate the negative relationship between entity beliefs about intelligence and reading comprehension strategy use.

4. Performance-approach goals will mediate the negative relationship between entity beliefs about intelligence and reading comprehension strategy use.

5. Reading efficacy beliefs will mediate the positive relationship between incremental beliefs about intelligence and reading comprehension strategy use.

With respect to the second research question, the following hypotheses are predicted:

1. Reading comprehension strategy use will mediate the positive relationship between mastery-approach goals and academic outcomes.

2. Reading comprehension strategy use will mediate the negative relationship between mastery-avoidance goals and academic outcomes.

3. Reading comprehension strategy use will mediate the positive relationship between performance-approach goals and academic outcomes.

4. Reading comprehension strategy use will mediate the negative relationship between performance-avoidance goals and academic outcomes.

5. Reading comprehension strategy use will mediate the positive relationship between reading efficacy beliefs and academic outcomes.

The specific hypotheses for the third research question are as follows:

1. Compared to the control group, the growth-mindset intervention group will have stronger incremental beliefs about intelligence.

2. Compared to the control group, the intervention group will have stronger mastery-approach achievement goals.

3. Compared to the control group, the intervention group will have weaker mastery-avoidance achievement goals.

4. Compared to the control group, the intervention group will have weaker performance-approach achievement goals.

5. Compared to the control group, the intervention group will have weaker performance-avoidance achievement goals.

6. Compared to the control group, the intervention group will have greater reading efficacy.

7. Compared to the control group, the intervention group will have a greater reading comprehension strategy use score.

8. Compared to the control group, the intervention group will use more deep-level reading comprehension strategies.

9. Compared to the control group, the intervention group will use more surface-level reading comprehension strategies.

10. Compared to the control group, the intervention group will have greater reading skill.

11. Compared to the control group, the intervention group will have stronger reading comprehension at the textbase.

12. Compared to the control group, the intervention group will have stronger reading comprehension at the situation model.

13. Compared to the control group, the intervention group will have better grades.

Chapter 3

METHODS

Participants

Beginning college learners in an Associate in Arts program at a large northeastern public university, all of whom were enrolled in one of twelve sections of a required first-year course, were recruited to participate in this research. The first-year course is a 15-week, one-credit course required of all first-year learners. It provides instruction in the following areas: academic skill development, goal-setting and time management, sexual harassment policy, academic policies and procedures, safety and wellness, academic integrity, diversity, bystander intervention, and selection of a major. As a part of this research, learners also received explicit reading comprehension strategy instruction through the iSTART online automated tutoring platform. Approximately 275 learners were enrolled in the participating course sections.

A statistical power analysis using G*Power 3.1 was performed for sample size estimation, based on the findings of a meta-analytic review of implicit theories conducted by Burnette et al. (2012). Relevant effect sizes in this study ranged from r = -.24 to r = .23 and are considered extremely small according to Cohen (1988). With an alpha = .05 and power = 0.80, the projected sample size needed to obtain an effect size f = .20 was approximately N = 190 for a MANOVA global effect, critical F = 1.776. The proposed sample of $N = 275$ was adequate for the main objective of this study and allowed for limited attrition.

The Associate in Arts Program is a two-year non-residential liberal arts degree program housed at three locations throughout the state. Satisfactory completion of the Associate in Arts Program is equivalent to completing the core requirements of a four-year degree and affords learners the opportunity to transition directly to the main campus to earn a bachelor's degree. Satisfactory completion of the Associate in Arts Program requires a minimum 2.0 GPA and 60 credit hours of coursework in mathematics, humanities, social sciences, natural sciences, and languages. Some learners in the Associate in Arts Program are in-state residents who applied but were not admitted to the four-year degree program on the main campus. The university automatically considers all in-state applicants who are not admitted to the four-year degree program for admittance into the Associate in Arts Program. According to the program administration, learners in the Associate in Arts Program typically have substantially lower standardized reading comprehension scores than learners on the main campus.

Learners enrolled in the first-year course for the Associate in Arts Program were selected to participate in this research for several reasons. First, although some first-year beginning college learners elect to enroll in the university's two-year Associate in Arts Program, some are assigned to the program because their academic histories indicate that they may need additional support in making the academic transition from high school to college. Because of learners' academic histories and placement in the Associate in Arts Program, they may be vulnerable to responding unproductively when faced with academic challenges, which made this group conducive for testing the growth-mindset intervention. Specifically, learners' academic mindsets may play a major role in how they respond to emerging academic challenges since they are aware that their academic skills are not as strong as learners who were accepted to the four-year program. For instance, learners maintaining fixed-mindset beliefs may be particularly sensitive to failure and negative feedback regarding the quality of their academic work.

Second, learners enrolled in the 15-week first-year course for the Associate in Arts Program were also selected to participate in this research because in contrast to the sections of the first-year course on the main campus, the Associate in Arts Program offers academic skill-building in addition to information about the university's policies, resources, and campus life. The academic skills covered in the first-year course include goal-setting, time management, motivation for learning, notetaking, effective communication, and assessment of academic progress. The focus on academic skill-building made it a natural platform for providing the iSTART training and growth-mindset intervention. Specifically, the iSTART training and the growth-mindset intervention align with the course objective of providing instruction and tools to enhance learners' study skills.

Design of Study

As previously stated, this research employed a randomized experimental design. The strength of this design is that it allowed for an examination of the effects of the treatment condition by comparing participants before and after they received growth-mindset instruction. Another strength is that it allowed for the comparison of the effects of intervention between the treatment and control groups. All participants, across the sample, were randomly assigned to either the treatment or control conditions. Participants in both the growth-mindset intervention and control groups received explicit reading comprehension strategy instruction via iSTART. Participants in the growth-mindset treatment condition participated in a brief social-psychological intervention to teach them about the malleability of intelligence and to let them know they could improve their intelligence through hard work and strategic effort. In contrast, participants in the control condition were taught about changes in the adolescent brain without information about the malleability of the brain.

Measures

Quantitative and qualitative data were collected for this research. First, background information was collected through the use of a demographic survey. Quantitative measures included pretest and posttest measures of implicit beliefs about intelligence, achievement goals, and reading comprehension efficacy. Other quantitative individual difference measures included prior knowledge, pretest and posttest reading skill, utility and cost-value evaluation of iSTART strategy use, semester GPA for learners' top two most extensive reading courses, and instructors' approaches to instruction surveys.

Qualitative artifacts included pretest and posttest reading comprehension strategy use, posttest reading comprehension, summaries of information presented during the treatment conditions, letters to struggling high-school learners, evaluations of the iSTART reading comprehension strategy training, three five-minute quick-write writing tasks, and instructor interviews.

Demographic Data

Learners were asked to provide demographic information about their gender, race/ethnicity (i.e., Asian, Black, Latino, White, or Other), high-school GPA, and intended college major (see Appendix B).

Implicit Theories of Intelligence

Learners' theories of intelligence were measured by the self-theory version of the Implicit Theories of Intelligence Scale (Castella & Byrne, 2015), which was based on Dweck (1999), but the items were reworded to measure beliefs pertaining to the first-person or self. The self-theory version was selected because the present research model focused on the influence of a brief covert growth-mindset intervention that was designed to alter learners' personal beliefs and behaviors.

Four items on the scale measured incremental beliefs and four items measured entity beliefs (see Appendix C). Sample incremental belief items included the following statements: "I believe I have the ability to change my basic intelligence level considerably over time" and "I believe I can always substantially improve on my intelligence." Sample entity belief items included the following statements: "My intelligence is something about me that I personally can't change very much" and "I don't think I personally can do much to increase my intelligence." Participants were asked to express their degree of agreement with each item using a 6-point response scale. Responses ranged from "strongly agree" to "strongly disagree." The four incremental belief items were reverse-scored. Afterwards, all eight items were summed to determine learners' levels of endorsement of incremental beliefs about intelligence. A higher composite score indicated greater endorsement of incremental beliefs. Castella and Byrne (2015) report high internal reliability for the scale, with a Cronbach's $\alpha = .90$.

The following qualitative data collected from participants were coded to determine the degree to which the artifacts reflected statements endorsing growth mindsets: (1) the summary of information presented during growth-mindset and control treatment conditions, (2) the letters written to a struggling learner, (3) the quick-writes, and (4) evaluation of the iSTART training.

Achievement Goals

Elliot and Murayama's (2008) revised Achievement Goal Questionnaire was employed to collect data consistent with their 2x2 achievement goal framework (see Appendix D). The scale consists of 12 items, with three items addressing each of the four goals. Sample items include, "My aim is to completely master the material presented in this class" (mastery-approach), "My goal is to avoid learning less than it is possible to learn" (mastery-avoidance), "I am striving to do well compared to other students" (performance-approach), and "My aim is to avoid doing worse than other students" (performance-avoidance). Participants were asked to respond using a 5-point response scale to indicate the degree to which they agreed with each statement, from "1 – I strongly disagree" to "5 – I strongly agree." Item scores for each of the four goals were averaged to form the four sub-scales. Research shows each sub-scale has high internal consistency: mastery-approach has a Cronbach's $\alpha = .84$, mastery-avoidance has a

Cronbach's $\alpha = .88$, performance-approach has a Cronbach's $\alpha = .92$, and performance-avoidance has a Cronbach's $\alpha = .94$ (Elliot & Murayama, 2008).

Reading Comprehension Efficacy

An adapted version of Anmarkrud and Bråten's (2009) Reading Efficacy Scale was used to measure participants' judgments of their reading comprehension ability (see Appendix E). The scale consists of seven items. Sample items include the following statements: "I will not have problems understanding even the most difficult texts that we read in college" and "Compared with the others in my classes I have a good understanding of books that I read." Participants' responses were measured on a 10-point scale ranging from "1 – never true of me" to "10 – always true of me." The reading efficacy scale has been found to be reliable, Cronbach's $\alpha = .85$.

Prior Knowledge

A 10-item multiple-choice test was used to measure prior topic knowledge. Similar to the procedure used in Anmarkrud and Bråten's (2009) scale, the exam referenced concepts covered in the text of the final assessment, and participants' scores reflected the number of correct responses. The assessment items and the correct responses are included in Appendix F. An assessment of prior knowledge was included in this research because research indicates that learners' prior topic and/or domain knowledge can account for a significant amount of the variance in learners' performances on reading comprehension tasks (Shapiro, 2004).

Pretest Reading Comprehension Strategy Use

Learners were asked to respond in writing to a written prompt (see Appendix G). The writing exercise was limited to five minutes and learners were informed that the recommended length of their responses was three to five sentences. This prompt was administered during the first class meeting before the start of iSTART training. It inquired about learners' typical use of reading comprehension strategies. A code sheet was created to code learners' responses according to the learning sub-scale of the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991). Most learners listed rehearsal strategies (i.e., strategies that support textbase comprehension), so frequency was used as measure of pretest strategy use.

Posttest Reading Comprehension Strategy Use

Two measures of posttest reading comprehension strategy use were employed. First, similar to Linderholm et al. (2014), the present research assessed the quality of the self-explanations of ten target sentences learners generated as portions of text appeared on a computer screen (see Appendix H). Trace evidence of learners' actual use of reading comprehension processing strategies was captured in the form of learners' self-explanations of target sentences using Qualtrics.

The quality of learners' self-explanations was measured by employing a multilevel manual coding procedure similar to the one described in Ozuru et al. (2010) to generate a reading comprehension strategy use score. First, the primary investigator and Coder 1 generated a coding guide by identifying the main ideas and concepts for each sentence of the text on the final assessment. Coder 1 holds a Ph.D. in Education.

Drawing on the guide, the two coders used the following criteria to assess learners' self-explanations of the target sentences. A score of zero was assessed for inaccurate paraphrases and self-explanations that were copied word for word from the text. One point was assessed for accurate but vague paraphrases that included at least one main idea. Two points were assessed for accurate paraphrases that included at least two main ideas. Three points were assessed for accurate paraphrases that included three or more main ideas. An additional point was awarded for each use of bridging, elaboration and prediction strategies.

Utilizing this coding system, an accurate but vague paraphrase was considered the lowest-quality self-explanation possible. Higher-quality self-explanations made connections between the details of an accurate and relevant paraphrase and accurate and relevant details in (1) previously read text located beyond the previous sentence, (2) learners' general or personal experiences, (3) learners' prior domain or topical knowledge, and/or (4) learners' prior knowledge that was used to make predictions about the future direction of the text. Higher-quality self-explanations may have included multiple instances of bridging, elaborations, or predictions.

Following the procedure outlined in Ozuru et al. (2010), the coders initially coded ten self-explanations together for the purposes of training, as well as to discuss and resolve discrepant coding. Afterwards the coders independently coded 5% of the self-explanations. Cohen's Kappa was used to examine inter-rater agreement. If the resulting kappa exceeded .70, the remaining self-explanations were divided among the two coders for independent coding A Cohen's kappa of .70 is generally seen as falling within the range of values indicating substantial inter-rater agreement (Landis & Koch, 1977; Viera & Garrett, 2005).

If the resulting kappa value was lower than .70, the coders reviewed the coding protocol and the self-explanations they had independently coded to resolve discrepant coding. Afterwards the coders independently coded an additional 5% of the self-explanations and Cohen's kappa was used to determine inter-rater agreement. If the kappa value was higher than .61, the remaining self-explanations were divided among the coders for independent coding. Kappa values of .61 to .80 indicate substantial inter-rater agreement (Landis & Koch, 1977; Viera & Garrett, 2005). If the resulting kappa value was less than .61, the aforementioned procedure was repeated until a Cohen's kappa of .61 was achieved.

These procedures were repeated to measure the quality of learners' self-explanations for each of the ten target sentences. For the ten target sentences, interrater agreement ranged from Cohen's kappa = .706 to 1.00.

Second, similar to McNamara (2004), the coders maintained a log of the individual strategies they coded in order to track the frequency of learners' reading comprehension strategy use. Specifically, the frequency of learners' use of the surface-level strategy of paraphrasing and use of deep-level comprehension strategies of bridging, elaboration, and prediction were measured.

Reading Comprehension

Similar to McNamara (2004) and O'Reilly et al. (2004), this research used open-ended questions to assess learners' comprehension of text at the textbase and situation models (the target text and reading comprehension assessment questions are included in Appendix I). Three questions designed to assess learners' comprehension of the target text at the textbase required learners to restate (paraphrase) a single sentence or idea from the text. Five questions were designed to assess learners' comprehension of the text at the situation model. Specifically, three questions required learners to generate bridging inferences that integrated at least two ideas within the text. Two questions required learners to generate elaborative inferences that connected the text to ideas and concepts beyond the text. Specifically, learners needed to draw upon their prior general knowledge to answer the questions. Learners were permitted to refer to the passages while completing the assessment.

Two teams of coders were used to code learners' responses to the reading comprehension questions. The primary investigator and Coder 2 coded learners' responses to reading comprehension questions 1 through 6. Coder 2 holds a Master's in Education. The primary investigator and Coder 3 coded learners' responses to questions 7 and 8. Coder 3 holds a Ph.D. in Educational Policy. Identical procedures were used by both teams to assess learners' responses. First, the coders generated a coding guide by identifying the primary ideas and concepts related to each question. The coders then coded ten responses to the first question together for the purposes of training, as well as to discuss and resolve discrepant coding. Afterwards, the coders independently coded 5% of the responses to the first question until Cohen's Kappa was equal to or exceeded .70. This process was repeated for each of the eight questions with the respective coders.

Coding for questions 1 through 6 had interrater agreement of Kappa = .752 to 1.00. For questions 7 and 8, interrater agreement was Kappa = .711 and .712, respectively.

The following criteria was used to assess learners' comprehension of the target text. A score of zero was assessed for an inaccurate response. One point was assessed for a partially accurate or vague response. Two points were assessed for an accurate but incomplete response. Three points were assessed for an accurate and complete response.

Reading Skill

Learners' reading comprehension skill was assessed before and after the growth-mindset intervention. The pretest and posttest reading skill assessments each consisted of 20 multiple-choice questions pertaining to two passages from the reading portion of the SAT practice test (College Board, 2016) and one passage from the ACT practice test (ACT, 2016). Pretest reading skill served as a baseline measure of individual difference. Posttest reading skill was included as an additional achievement outcome measure. Learners were allotted 15 minutes to read three passages and answer 20 multiple-choice comprehension items. Learners were permitted to refer to the passages while completing the assessment. The pretest and posttest assessment items, along with the correct responses, are included in Appendices J and K, respectively.

Academic Achievement

Learners' average grades for the two courses they identified as requiring the most extensive reading during the semester were used as a measure of academic achievement.

Experimental Condition Fidelity Check: Summary of Treatment Condition

Learners' written summaries of their treatment condition, growth-mindset (see Appendix L) or control (see Appendix M), were coded and analyzed for evidence of growth-mindset beliefs. These data provided evidence of the fidelity of the growth-mindset treatment condition implementation in terms of participants' understanding of the information presented.

Experimental Condition Fidelity Check: Letter to a Struggling High-School Student

Learners' letters to a struggling high-school student were coded and analyzed for evidence of growth-mindset beliefs. The writing prompts for learners in the growth-mindset and control treatment conditions are provided in Appendices L and M, respectively. These data provided evidence of the fidelity of the growth-mindset treatment condition implementation in terms of participants' responsiveness to the information presented.

Experimental Condition Sustained Fidelity Check

Learners were asked to respond in writing to a written prompt. The writing exercise was limited to five minutes and learners were informed that the recommended length of their responses was three to five sentences. The third quick-write was administered after the iSTART training had been completed to test the sustained fidelity of the growth-mindset intervention. It also checked for the effects of cross-communication between learners regarding the information they had learned in their respective treatment conditions. If learners in the growth mindset treatment group shared their information with learners in the control treatment group, it could reduce the observed differences between the two groups and threaten the internal validity of the study (Craven, Marsh, Debus & Jayasinghe, 2001). The writing prompt is included in Appendix N.

Use of iSTART Strategies

Learners were asked to respond in writing to a written prompt. The writing exercise was limited to five minutes and learners were informed that the recommended length of their responses was three to five sentences. This prompt was administered electronically after learners were scheduled to complete their second set of practice activities. This quick-write inquired whether learners were using the iSTART strategies to complete reading assignments in other classes (see Appendix O). These data were examined to identify themes that validated and contextualized quantitative findings.

Utility Value

Learners' perceptions of the utility value associated with using the iSTART strategies were measured with an adapted version of the MSLQ (Pintrich et al., 1991). The MSLQ utility value scale consists of six items (see Appendix P). A sample item is, "I think I will be able to use the strategies I learned in iSTART in other courses." Participants' responses were measured on a 7-point response scale ranging from "1 – not at all true of me" to "7 – very true of me." The MSLQ is widely used in educational research and has been found to be reliable with Cronbach's $\alpha = .90$.

Cost Value

Learners' perceptions of the cost value associated with using the iSTART strategies was measured with an adapted version of the Task Effort Cost Scale designed by Flake, Barron, Hulleman, McCoach, and Welsh (2015). The scale consists of five items (see Appendix P). A sample item is, “I think using the iSTART strategies requires too much effort.” Participants’ responses were measured on a 7-point response scale ranging from “1 – not at all true of me” to “7 – very true of me.” The Task Effort Cost Scale has been found to be reliable with Cronbach’s $\alpha = .95$.

Evaluation of iSTART Strategy Use

Qualitative data were collected regarding learners’ thoughts, beliefs, and behaviors about using the iSTART strategies in other courses (see Appendix Q). The first question asked learners to report the number of pages they were required to read in their other classes as well as whether they had used iSTART strategies to improve their comprehension. The second question contained multiple parts. First, it asked learners to identify the iSTART strategies they had used in other classes. Next, it asked learners to briefly describe how often and how they had used the iSTART strategies in other classes. Lastly, it asked learners to discuss which iSTART strategies had been most and least useful for them. The third and final question explored learners’ perspectives of the impact the iSTART strategies had made on their ability to comprehend difficult texts. These data were examined to identify themes that validated and contextualized quantitative findings.

iSTART Checkpoint Scores

Learners’ scores earned on iSTART training module checkpoint assessments were obtained from the iSTART platform.

iSTART Practice

Learners' scores earned on the four independent practice texts were obtained from the iSTART platform.

iSTART Active Practice

Two measures of active practice were obtained from the iSTART platform. These data included the number of texts learners self-explained in iSTART, the number of training videos watched in iSTART, and the amount of time spent working on iSTART practice texts. With regard to the amount of time spent working on practice texts, the iSTART platform monitors learners' traces as they work on practice activities. Learners' time spent actively practicing was recorded. Active practice was distinguished from dormant time when learners were logged onto the system but not actively working on an iSTART task.

Instructors' Approaches to Instruction

Instructors' perceptions of messages about the goals and purposes of learning that they communicated through instructional practices were measured by the two subscales comprising the Approaches to Instruction Scale of the Patterns of Adaptive Learning Scales (see Appendix R). The mastery approaches subscale consists of four items with Cronbach's $\alpha = .69$. The performance approaches subscale consists of five items with Cronbach's $\alpha = .69$. These measures were used to account for the differences learners experienced in the various sections of the first-year course. Slight rewording of a few items was necessary to incorporate language reflective of a college course versus that of a secondary education classroom (e.g., “assign course grades” instead of “give them report card grades”).

Instructor interview protocol. Instructors participated in a 75-minute in-person audio-recorded interview. Instructors were asked to respond to 21 open-ended questions about the course and learners’ engagement. The instructor interview protocol can be found in Appendix S. These data were examined to identify themes that validated and contextualized quantitative findings.

Procedures

For each section of the first-year course, collecting data, executing the growth-mindset intervention, and completing the iSTART training procedure occurred over an eight-week period and required three 50-minute sessions in a computer lab during class time. Over the eight-week period, learners actually spent four weeks working with iSTART. The total time for learners participating in this research was estimated to be 6 hours and 25 minutes. Below is an overview of the procedures that were used for this research. Table 3 provides a summary of the estimated time learners spent on each task. Instructors spent approximately 90 minutes completing the consent form, one survey and an interview.

Week 1

During the first computer lab session, the researcher introduced learners to the iSTART automated tutorial platform (10 minutes). Once learners were comfortable navigating the system, this study was introduced. Learners were provided with an overview of the study and given the opportunity to ask questions (15 minutes). Learners were asked to electronically consent or decline to participate in this study (15 minutes). Finally, learners completed the demographic data form (10 minutes). Instructors were also asked to complete a consent form and the Approaches to Instruction survey (15 minutes).

Weeks 1-3

Following the first computer lab session, participants were asked to independently complete pretest motivational inventories and the first quick-write regarding their use of reading comprehension strategies (15 minutes). Participants were also asked to complete a baseline (pretest) assessment of reading comprehension skill (15 minutes). In addition, participants were randomly assigned to one of two treatment groups: growth-mindset treatment group or control group.

Week 4

During the second computer lab session, learners participated in the growth-mindset intervention (50 minutes). Learners in the intervention group watched a short video and read a brief article about the benefits of maintaining a growth mindset. The control group participants simultaneously followed the same procedure, except their materials focused on how the brain works without any references to the malleability of the brain. The articles were presented as “scientifically based” (15 minutes).

The videos for the control group (2:59 minutes in length) and intervention group (2:31 minutes in length) were approximately equal in length, differing by only 28 seconds.

The scientific texts were comparable in length; however, they differed in readability. The growth-mindset text contained 794 words and a Flesch-Kincaid reading grade level of 12. The control group text contained 793 words and a Flesch-Kincaid reading grade score of 8.6.

Using the procedures described in Paunesku et al. (2015), upon completion of the respective treatments, participants were asked to summarize the scientific findings of the respective articles (10 minutes), as well as to draw upon the information they had learned to write an advice letter to a learner who was struggling academically and thinking of dropping out of high school (15 minutes). See Appendices L and M for the respective advice letter instructions for the growth-mindset and control treatment groups.

After completing the growth-mindset intervention, learners began and completed the initial iSTART training and completed the first practice assignment (approximately 1 hour and 5 minutes).

Week 5

Learners completed the second iSTART practice assignment (30 minutes).

Week 6

Learners completed the third iSTART practice assignment (35 minutes). Participants were also asked to electronically complete a second quick-write regarding their use of reading comprehension strategies in other courses (5 minutes).

Week 7

Learners completed the fourth iSTART practice assignment (30 minutes).

Week 8

During the third computer lab session, the learners completed the assessment of prior knowledge (10 minutes) and the final reading comprehension task. Learners were asked to self-explain the text Tracing Linguistic Diversification on iSTART (20 minutes) and complete the comprehension assessment (20 minutes). Participants were asked to answer eight open-ended comprehension questions about the text. Three questions measured comprehension at the textbase and five questions measured comprehension at the situation model. Learners who completed the assessment early were given the opportunity to work on completing the posttest measures listed below.

Following the final assessment, participants were asked to independently complete the posttest motivational measures (10 minutes), the posttest reading comprehension skill assessment (15 minutes), the evaluation of iSTART strategies (10 minutes), and the third quick-write to test the sustained fidelity of the growth-mindset intervention (5 minutes).

After the end of the semester, instructors were interviewed about the topics and skills taught in their course as well as any feedback or questions they had received from students about iSTART (75 minutes).

Table 3

Summary of Student Procedures

Week	**Procedure**	**Time on Task**
Week 1	In class – Introduction, informed consent, demographic data	50 minutes
Week 1-3	Independently – Pretest motivational inventories, the first quick-write regarding their use of reading comprehension strategies. Participants were also asked to complete the pretest reading comprehension skill assessment.	30 minutes
Week 4	In class – Growth-mindset intervention and control group treatment.	50 minutes
Week 4	Independently – iSTART training and first practice activity	65 minutes
Week 5	Independently – Second practice activity	30 minutes
Week 6	Independently – Third practice activity and second quick-write	40 minutes
Week 7	Independently – Fourth practice activity	30 minutes
Week 8	In class – Prior knowledge, self-explain final comprehension text, reading comprehension final task	50 minutes
Week 8	Independently – Posttest motivational measures, posttest reading comprehension skill assessment, the evaluation of iSTART strategies, and the third quick-write	40 minutes
Total Time on Tasks		**6 hours and 25 minutes**

Materials

Growth-Mindset Intervention Group

Learners assigned to the growth-mindset intervention group viewed the video entitled *Growth Mindset Video* (2:31 minutes). In addition, they read a scientific text entitled “Mindset: Why do some people reach their full potential, while others of equal talent, do not?” The scientific article was derived from several source documents (see Appendix L), including “Discover Your Mindset” (Thrive, 2012); “Mindsets and Math/Science Achievement” (Dweck, 2008); and “The Brain Toolkit” (Thrive, 2011).

Control Group

Learners assigned to the control group viewed a video entitled *The Teen Brain: Under Construction* (2:59 minutes). In addition, they read a scientific text entitled “Zooming to New Connections: A Summary of Brain Growth in Adolescence.” The scientific article (see Appendix M) was derived from *Brain Zooming* (Thrive, 2010).

Target Text

Participants read a college-level expository text on the diffusion of languages (see Appendix I). The target text, entitled “Tracing Linguistic Diversification,” was an excerpt from a linguistics text (de Blij & Murphy, 1999) and consisted of 886 words in 50 sentences. On average, there were 17.70 words per sentence. In keeping with the focus of this study, a complex college-level text was selected for the reading task. The text had a Flesch-Kincaid Reading Ease score of 40.5. Flesch-Kincaid Reading Ease scores ranging from 30.0 to 50.0 are considered college-level and difficult to read. Linguistics was selected because most beginning college learners are likely to have some exposure to languages other than English, either through personal interactions or exposure to a foreign language during kindergarten through twelfth grade. Few beginning college learners, however, are expected to have had a course that focused on the origins of modern-day languages. The goal of focusing on this obscure topic was to reduce the role of prior knowledge on learners' reading comprehension assessment scores.

Following a similar procedure described in Ozuru et al. (2010), ten target sentences were selected for learners to self-explain based upon the following criteria: (1) comprehension of the sentence is critical to understanding the text, and (2) accurate understanding of the target sentence is dependent upon making connections with details in previous sentences.

Text presentation. The Qualtrics platform was used to present the target text for assessing the quality of learners' self-explanations and reading comprehension. The text was presented two to three sentences at a time and target sentences were presented in bold font style. This cycle repeated until learners completed reading and self-explaining the text. This procedure was similar to learners' experiences providing self-explanations in iSTART.

Comprehension questions. Participants were asked to respond to eight open-ended questions to assess their comprehension of the target text (see Appendix I). Three questions assessed comprehension at the textbase, requiring learners to paraphrase information found in one sentence or in two or three adjoining sentences within a paragraph. Comprehension at the textbase did not require learners to activate their general or domain knowledge. All the information they needed to respond to the question was found explicitly in the text (Kintsch, 1998).

Five questions were designed to assess learners' comprehension at the situation model. Comprehension at the situation model required learners to move beyond textbase representations of the text by bridging ideas throughout the text and/or incorporating their own knowledge to make inferences about the ideas and concepts within the text to generate a cohesive mental representation of the entire text (Kintsch, 1998).

Three situation-model questions were classified as bridging questions and required learners to integrate information located in separate paragraphs throughout the text. Answering these questions correctly required learners to construct a globally cohesive mental representation of the text by using their general and/or domain knowledge to connect multiple ideas and concepts found throughout the text (Barth et al., 2015).

Two situation-model questions were classified as elaboration questions and required learners to connect ideas in the text to their prior knowledge. Answering these questions correctly required learners to generate a coherent mental model of text, integrating the concepts and ideas they had read about with their knowledge of the world and/or prior domain knowledge (Kendeou et al., 2014; Oakhill et al., 2003). Learners were able to access the entire text as they answered the comprehension questions.

Interactive Strategy Training for Active Reading and Thinking (iSTART)

All learners were provided with a unique login and password for iSTART. When learners logged in to iSTART, they were brought to the *Practice* page. To start the training, they clicked on the *Training* tab and then the *Overview* icon. In the *Overview* section, learners were greeted by Mr. Evans, an animated pedagogical agent who guided them through the eight iSTART training modules: (1) the overview, (2) monitoring, (3) paraphrasing, (4) prediction, (5) elaboration, (6) bridging, (7) summary, and (8) demonstration. A brief overview of the iSTART strategies is provided in Table 4.

In addition to completing the eight training modules, learners completed four iSTART practice assignments and four mini games to practice using the self-explanation technique and the five reading comprehension strategies. All practice activities and mini games were accessible by clicking on the *Practice* tab in iSTART.

Table 4

Overview of Reading Strategies Taught in iSTART

Comprehension Strategy	Description	Strategy Use
Comprehension Monitoring	Monitoring your comprehension means you continuously check to see if you understand what you are reading.	1. Pay attention to what you do and do not understand. 2. Continuously ask yourself questions as you read, such as: (a) Did I understand what I just read? (b) Which parts of the text made sense? (c) Which parts did not make sense?
Prediction	Predicting means to think ahead about what the text might cover next.	1. Consider what you have already read. 2. Ask yourself questions about what you have read. 3. Self-explain the answers to your questions, then make educated guesses about what comes next. 4. If you can't guess what might come next, focus on understanding what you have already read and try again.
Paraphrasing	Paraphrasing means to rewrite the text in your own words.	1. Think about what you have read. 2. Self-explain and use different words to describe what the text is saying.
Elaboration	Elaboration means connecting the text to your knowledge of the world.	1. Think about what you have read. 2. Ask yourself questions about what related information you already know. 3. Self-explain and add in what you already know by drawing on world knowledge, logic, and common sense
Bridging	Bridging means connecting the current idea to other parts of the text.	1. Think about what you have already read. 2. Consider using elaboration to help you bridge ideas. 3. Self-explain and use what you have already read to explain new information you read in the text.

iSTART training for this research was estimated to take 2 hours and 40 minutes, including 40 minutes for training and two hours of assigned practice. According to McNamara, Levinstein, and Boonthum (2004), initial iSTART training modules (i.e., the instruction on self-explanation and the reading strategies) require about 30 minutes to complete. However, the researchers recommend that learners engage in extended practice by utilizing some of the gaming technology incorporated into the system (Jackson, Boonthum, & McNamara, 2010). The present research study introduced learners to several of the games in iSTART and encouraged learners to practice independently. A detailed description of the iSTART training, practice activities, and mini games is provided in Appendix A.

Chapter 4

QUANTITATIVE RESULTS

As discussed in Chapter 1, this study examined the following three research questions:

1. Do motivational beliefs mediate the relationship between implicit theories of intelligence and reading comprehension strategy use?

2. Does reading comprehension strategy use mediate the relationship between motivational beliefs and achievement outcomes?

3. Does a growth-mindset intervention influence learners' endorsement of implicit intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes?

First, this chapter will provide background data for the teacher and student participants. Second, descriptive statistics and correlational data for Time 1 and Time 2 variables are summarized. Third, the inferential and nonparametric results are presented for each of the three research questions. Finally, key findings of the quantitative analyses are summarized.

Descriptive and Correlational Analyses

The students in a required first-year course of an AA program at a large northeastern public university participated in the study. The nine sections of the course were taught by three instructors at two regional campuses. One of the instructors taught three sections at Campus 2, another instructor taught three sections at Campus 1, and the last instructor taught two sections at Campus 1 and one section at Campus 2.[1]

One hundred ninety-four first-year college learners, all of whom were enrolled in one of these nine sections of the first-year course, were eligible to participate in this study. One hundred eighty-six students provided informed consent and agreed to participate. One student withdrew from the study. One student provided invalid responses on several surveys, and ten students did not complete the treatment condition protocol; consequently, their data were excluded from all analyses ($N = 174$). Attrition was similar across both campuses and among all instructors. The participating students were equally distributed among the three instructors: 56 students were from Instructor 1's classes, 61 were from Instructor 2's classes, and 57 were from Instructor 3's classes. Learners were randomly assigned to either the growth-mindset or control treatment condition. Tables 5 and 6 summarize their distribution by campus and instructor, respectively.

Missing data were also analyzed. The majority of the missing data were from the growth-mindset group in Instructor 1's courses on Campus 2. The missing data analysis is presented after the correlations analyses at the end of this section.

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[1] Initially, participants were to be recruited from 12 course sections across three campus locations, but one of the sites was unable to participate in this research because a computer lab was not available for use during course meeting times.

Table 5

Descriptive Statistics for Treatment Condition Assignment by Campus

Campus		Control Treatment	Growth Mindset Treatment	Total
Campus 1	Count	66_a	33_b	99
	% within Campus 1	66.7%	33.3%	100.0%
	% within Treatment	73.3%	39.3%	56.9%
Campus 2	Count	24_a	51_b	75
	% within Campus 2	32.0%	68.0%	100.0%
	% within Treatment	26.7%	60.7%	43.1%
Total	Count	90	84	174
	% within Campus	51.7%	48.3%	100.0%
	% within Treatment	100.0%	100.0%	100.0%

Note. Each subscript letter denotes a subset of the Treatment Condition categories whose column proportions do not differ significantly from each other at the .05 level.

Table 6

Descriptive Statistics for Treatment Condition Assignment by Instructor

Course Instructor		Control Treatment	Growth Mindset Treatment	Total
Instructor 1	Count	22_a	34_b	56
	% within Instructor 1	39.3%	60.7%	100.0%
	% within Treatment	24.4%	40.5%	32.2%
Instructor 2	Count	45_a	16_b	61
	% within Instructor 2	73.8%	26.2%	100.0%
	% within Treatment	50.0%	19.0%	35.1%
Instructor 3	Count	23_a	34_b	57
	% within Instructor 3	40.4%	59.6%	100.0%
	% within Treatment	25.6%	40.5%	32.8%
Total	Count	90	84	174
	% within Course Instructor	51.7%	48.3%	100.0%
	% within Treatment	100.0%	100.0%	100.0%

Note. Each subscript letter denotes a subset of the Treatment Condition categories whose column proportions do not differ significantly from each other at the .05 level.

Tables 7 and 8 provide the descriptive data for participating students' gender and racial and ethnic backgrounds. There were slightly more males (n = 87) than females (n = 84). Three students self-identified as having a non-specific gender. The students' ages ranged from 17 to 33 years (*M* = 18.37, *SD* = 1.4). Additionally, 60% of learners were White, 13% were Black, 11% were Latino, 5% were Asian, and 11% were multiracial and/or multiethnic.

Qualtrics software was used to deliver the growth-mindset intervention and collect data. The software contains a "randomizer" that can be used to randomly assign participants to different groups or conditions. As a result of random assignment by Qualtrics, 90 students were assigned to the control treatment group and 84 to the growth-mindset treatment condition. The gender distributions across the control and treatment group were relatively equal. The control group had an equal number of females and males, but the growth-mindset treatment group had slightly more males ($n = 43$) than females ($n = 40$). The control group was more ethnically and racially diverse than the growth-mindset treatment group. Specifically, White students comprised approximately half of the participants in the control group and two-thirds of the participants in the growth-mindset group. Crosstabs and Pearson's chi-square statistic were used to test proportional differences in racial and ethnic group assignment to the control and growth-mindset treatment conditions. There was no significant difference in the racial and ethnic composition of the treatment conditions (χ^2 (4) = 4.490, $p = .34$).

Table 7

Descriptive Statistics for Gender by Treatment Condition

Gender		Control Group	Growth-Mindset Group	Total
Female	Count	44_a	40_a	84
	% within Treatment	48.9%	47.6%	48.3%
Male	Count	44_a	43_a	87
	% within Treatment	48.9%	51.2%	50.0%
Other	Count	2_a	1_a	3
	% within Treatment	2.2%	1.2%	1.7%
Total	Count	90	84	174
	% within Treatment	100.0%	100.0%	100.0%

Note. "Other" includes count for learners who self-identify using terms that are non-gender-specific. Each subscript letter denotes a subset of treatment categories whose column proportions do not differ significantly from each other at the .05 level.

Table 8

Descriptive Statistics for Race and Ethnicity by Treatment Condition

Racial/Ethnic Group		Control Group	Growth-Mindset Group	Total
Black/African American	Count	15_a	8_a	23
	% within Treatment	16.7%	9.5%	13.2%
Latino/Hispanic	Count	12_a	7_a	19
	% within Treatment	13.3%	8.3%	10.9%
Asian/Pacific Islander	Count	4_a	4_a	8
	% within Treatment	4.4%	4.8%	4.6%
White	Count	48_a	57_a	105
	% within Treatment	53.3%	67.9%	60.3%
Multiethnic/racial	Count	11_a	8_a	19
	% within Treatment	12.2%	9.5%	10.9%
Total	Count	90	84	174
	% within Treatment	100.0%	100.0%	100.0%

Note. "Multiethnic/racial" includes learners who self-identify as biracial or triracial/ethnic (e.g., Black/African American and Native American; or Latino, Asian, and White, respectively). Each subscript letter denotes a subset of treatment categories whose column proportions do not differ significantly from each other at the .05 level.

Tables 9 and 10 provide the descriptive data for gender and racial and ethnic background by campus location. Crosstabs and Pearson's chi-square statistic were used to test proportional differences in gender by campus location. There was no statistical difference in gender proportions at each campus (χ^2 (2) = 2.441, p = .30). With regard to race, Campus 1 was more ethnically and racially diverse than Campus 2. Crosstabs and Pearson's chi-square statistic show that there was a significant difference in racial and ethnic proportions at each campus, χ^2 (4) = 16.900, $p < .01$. This difference reflects a medium effect, Cramer's $V = .312$, $p < .01$. Black students comprised 19.2% of participants at Campus 1 and 5.3% at Campus 2; White students comprised 50.5% of the participants at Campus1 and 73.3% of the participants at Campus 2; and multiethnic/racial students comprised 16.2% of participants at Campus 1 and 4.0% at Campus 2.

Tables 11 and 12 provide the descriptive data for gender and racial and ethnic background by course instructor. Crosstabs and Fisher's exact test were used to examine proportional differences in gender by instructor. Fisher's exact test was used because the expected cell count was less than five in three of the crosstab cells (Field, 2015). Results showed no significant difference between the gender proportions of participants taught by each instructor ($p = .379$, 2-sided Fisher's exact test).

With regard to race/ethnicity, the learners taught by Instructor 2 represented a more ethnically and racially diverse group than those taught by Instructor 1. Crosstabs and Fisher's exact test showed there was a significant difference in the proportional racial and ethnic composition by instructor ($p = .02$, 2-sided Fisher's exact test). Crosstabs showed that Black students comprised 5.4% of participants taught by Instructor 1 and 23.0% taught by Instructor 2. White students comprised 71.4% of participants taught by Instructor 1 and 49.2% taught by Instructor 2.

Table 9

Descriptive Statistics for Gender by Campus

Gender		Campus 1	Campus 2	Total
Female	Count	46_a	38_a	84
	% within Campus	46.5%	50.7%	48.3%
Male	Count	50_a	37_a	87
	% within Campus	50.5%	49.3%	50.0%
Other	Count	3_a	0_a	3
	% within Campus	3.0%	0.0%	1.7%
Total	Count	99	75	174
	% within Campus	100.0%	100.0%	100.0%

Note. "Other" includes count for learners who self-identify using terms that are non-gender-specific. Each subscript letter denotes a subset of campus categories whose column proportions do not differ significantly from each other at the .05 level.

Table 10

Descriptive Statistics for Race and Ethnicity by Campus

Racial/Ethnic Group		Campus 1	Campus 2	Total
Black/African American	Count	19_a	4_b	23
	% within Campus	19.2%	5.3%	13.2%
Latino/Hispanic	Count	11_a	8_a	19
	% within Campus	11.1%	10.7%	10.9%
Asian/Pacific Islander	Count	3_a	5_a	8
	% within Campus	3.0%	6.7%	4.6%
White	Count	50_a	55_b	105
	% within Campus	50.5%	73.3%	60.3%
Multiethnic/racial	Count	16_a	3_b	19
	% within Campus	16.2%	4.0%	10.9%
Total	Count	99	75	174
	% within Campus	100.0%	100.0%	100.0%

Note. "Multiethnic/racial" includes learners who self-identify as biracial or triracial/ethnic (e.g., Black/African American and Native American; or Latino, Asian, and White, respectively). Each subscript letter denotes a subset of campus categories whose column proportions do not differ significantly from each other at the .05 level.

Table 11

Descriptive Statistics for Gender by Instructor

Gender		Instructor 1	Instructor 2	Instructor 3	Total
Female	Count	28_a	29_a	27_a	84
	% within Course Instructor	50.0%	47.5%	47.4%	48.3%
Male	Count	28_a	29_a	30_a	87
	% within Course Instructor	50.0%	47.5%	52.6%	50.0%
Other	Count	0_a	3_a	0_a	3
	% within Course Instructor	0.0%	4.9%	0.0%	1.7%
Total	Count	56	61	57	174
	% within Course Instructor	100.0%	100.0%	100.0%	100.0%

Note. “Other” includes count for learners who self-identify using terms that are non-gender-specific. Each subscript letter denotes a subset of course instructor categories whose column proportions do not differ significantly from each other at the .05 level.

Table 12

Descriptive Statistics for Race and Ethnicity by Instructor

Racial/Ethnic Group		Instructor 1	Instructor 2	Instructor 3	Total
Black/African American	Count	3_a	14_b	$6_{a, b}$	23
	% within Course Instructor	5.4%	23.0%	10.5	13.2%
Latino/Hispanic	Count	6_a	8_a	5_a	19
	% within Course Instructor	10.7%	13.1%	8.8%	10.9%
Asian/Pacific Islander	Count	5_a	1_a	2_a	8
	% within Course Instructor	8.9%	1.6%	3.5%	4.6%
White	Count	40_a	30_b	$35_{a, b}$	105
	% within Course Instructor	71.4%	49.2%	61.4%	60.3%
Multiethnic/racial	Count	2_a	8_a	9_a	19
	% within Course Instructor	3.6%	13.1%	15.8	10.9%
Total	Count	56	61	57	174
	% within Course Instructor	100.0%	100.0%	100.0%	100.0%

Note. “Multiethnic/racial” includes learners who self-identify as biracial or triracial/ethnic (e.g., Black/African American and Native American; or Latino, Asian, and White, respectively). Each subscript letter denotes a subset of course instructor categories whose column proportions do not differ significantly from each other at the .05 level.

Time 1 Measures

Data were first examined to identify problematic responses. All invalid responses were excluded from the analyses, including a sizeable number of reading comprehension efficacy responses (n = 17). Specific to the reading comprehension efficacy survey, there was evidence that some respondents clicked a single numerical response for every item. In addition, a cross-check of items identified cases that exhibited a singular direction of response, despite two items being reverse-coded. This may indicate that learners were disengaged or had misread the item(s). These 17 responses were from ten learners who were enrolled at Campus 2 and seven students at Campus 1. Of the 17 responses, eight were from learners in Instructor 1's classes, four were from Instructor 2's classes, and five were from Instructor 3's classes.

Data were analyzed using IBM's SPSS 25. Distributions of the data were examined. Histograms, stem and leaf plots, and *z*-scores were used to test for normality, including skewness, kurtosis, and the presence of extreme ($z > 3.29$), probable ($z > 2.58$) and potential ($z > 1.96$) outlying scores. Table 13 provides a summary of outliers for each variable, as well as how they were handled for the purposes of these analyses. With the exception of two Time 1 (T1) variables (strategy use and reading skills), outliers were treated as missing data. Outliers for strategy use and reading skills were capped, meaning they were recoded to the highest score among data points within the range of the normal distribution (Osborne & Overbay, 2004). These data were capped to normalize the distribution rather than treated as missing because they represent valid scores that the learners had earned on the respective tasks.

Table 13

T1 Outliers

Variable	Extreme Outliers	Probable Outliers	Resolution
T1 Incremental	2	3	Missing
T1 Entity	1	2	Missing
T1 Intelligence Theory	1	-	Missing
T1 Mastery-Approach	1	-	Missing
T1 Mastery-Avoidance	-	-	Missing
T1 Perform-Approach	3		Missing
T1 Perform-Avoidance	4	-	Missing
T1 Reading Efficacy	-	3	Missing
T1 Strategy Use	2	-	Capped
T1 Reading Skill	6	-	Capped
High-School GPA	-	4	Missing
SAT-Reading	-	-	N/A

Note. Z-scores were used to identify extreme ($z > 3.29$) and probable ($z > 2.58$) outliers. All invalid scores and most outliers were coded as missing and excluded from subsequent analyses, with the exception of high outliers among strategy use and reading skill scores, which were capped, meaning they were recoded to the highest score among data points within the range of the normal distribution (Osborne & Overbay, 2004).

Skewness and kurtosis were improved for all affected variables after invalid cases were omitted and outliers were removed or capped. T1 descriptive statistics are presented in Table 14, which includes a summary of the distribution of the data, mean, and standard deviation scores, as well as skewness and kurtosis statistics.

Table 14

T1 Descriptive Statistics

Variable	*N*	MIN	MAX	*M*	*SD*	Skewness		Kurtosis	
							Std. Error		Std. Error
T1 Incremental	169	3.25	6.00	5.14	.70	-.48	.19	-.38	.37
T1 Entity	171	1.00	4.25	2.12	.82	.50	.19	-.34	.37
T1 Intelligence Theory	173	3.00	6.00	4.96	.75	-.52	.19	-.21	.37
T1 Mastery-Approach	173	2.67	6.00	5.00	.87	-.76	.19	-.10	.37
T1 Mastery-Avoidance	174	1.00	6.00	3.89	1.28	-.16	.18	-.63	.37
T1 Perform-Approach	171	2.00	6.00	4.80	.97	-.68	.19	-.08	.37
T1 Perform-Avoidance	170	1.67	6.00	4.70	1.13	-.66	.19	-.42	.37
T1 Reading Efficacy	154	2.86	10.00	6.46	1.36	-.07	.20	-.03	.39
T1 Strategy Use	172	1.00	3.00	2.05	.72	-.07	.19	-1.08	.37
T1 Reading Skill	168	1.00	11.00	5.57	2.71	.44	.19	-.60	.37
SAT-Reading	146	300	800	556.01	109.03	.14	.20	-.38	.40
High-School GPA	164	2.70	4.30	3.55	.35	-.43	.19	-.62	.38

Note. Intelligence theory is the summed entity beliefs and reverse-scored incremental beliefs scales (low score is extreme entity and high score is extreme incremental). Strategy use, high-school GPA, and SAT-Reading were self-reported.

T1 correlational data are provided in Table 15. Few large correlations were observed among the T1 data. Most correlations were weak, falling below $r = .39$. As expected, mastery-approach goals was positively related to incremental beliefs ($r = .35$, $p < 0.01$) and negatively related to entity beliefs ($r = -.20$, $p < 0.01$). Reading efficacy beliefs was also negatively related to entity beliefs ($r = -.22$, $p < 0.01$).

Several unexpected correlations were also observed. For instance, reading efficacy beliefs was unrelated to incremental beliefs. In addition, performance-approach goals was positively related to incremental beliefs ($r = .24$, $p < 0.01$) and unrelated to entity beliefs. Finally, strategy use was unrelated to intelligence beliefs, reading efficacy, the four motivational variables, and the three achievement measures.

Multicollinearity was apparent between T1 incremental and entity beliefs ($r = -.74$, $p < 0.001$). According to Stevens (2002), multicollinearity exists when two or more variables are moderately or highly correlated. Multicollinearity is assumed when $r = .70$ or higher. Multicollinearity can be problematic in some statistical analyses that rely on regression because it can adversely affect the parameter estimates and standard errors of the affected variables (Vatcheva, Lee, McCormick, & Rahbar, 2016). To address multicollinearity, a composite T1 intelligence theory variable was formed from the entity beliefs and reverse-scored incremental beliefs scales, whereby a low score (1) reflects high entity beliefs and a high score (6) reflects high incremental beliefs. Similar procedures were used in measuring implicit beliefs about intelligence by Blackwell et al. (2007).

Table 15

T1 Correlations

Variable	1	2	3	4	5	6	7	8
1 T1 Incremental	**-**							
2 T1 Entity	**-.741****	**-**						
3 T1 Intelligence Theory	**.919****	**-.910****	**-**					
4 T1 Mastery-Approach	**.351****	**-.204****	**.326****	**-**				
5 T1 Mastery-Avoidance	**.014**	**-.085**	**.065**	**.295****	**-**			
6 T1 Perform-Approach	**.239****	**-.106**	**.178***	**.577****	**.184***	**-**		
7 T1 Perform-Avoidance	**.149**	**-.125**	**.140**	**.401****	**.377****	**.637****	**-**	
8 T1 Reading Efficacy	**.141**	**-.216****	**.205***	**.152**	**-.011**	**.241****	**-.001**	**-**
9 T1 Strategy Use	**-.040**	**.076**	**-.054**	**.015**	**-.024**	**.022**	**-.014**	**-.099**
10 T1 Reading Skill	**-.067**	**-.053**	**.009**	**.048**	**-.061**	**.043**	**-.015**	**.303****
11 SAT-Reading	**.043**	**-.036**	**.011**	**.077**	**-.008**	**.027**	**-.078**	**.020**
12 High-School GPA	**.013**	**.001**	**.047**	**.019**	**.104**	**.069**	**.089**	**.104**

Table 15 (*Continued*)

9 Strategy Use	**-**			
10 Reading Skill	**.037**	**-**		
11 SAT-Reading	**.111**	**-.046**	**-**	
12 High School GPA	**.049**	**.164***	**-.235****	**-**

Note. Intelligence theory is the summed entity beliefs and reverse-scored incremental beliefs scales (low score is extreme entity and high score is extreme incremental). Strategy use, high-school GPA, and SAT-Reading were self-reported.
*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

The differences between scores at Time 1 for the control and growth-mindset treatment conditions were analyzed with the *t*-test for two independent samples. Results are presented in Table 16. There was no statistical difference between participants assigned to the control and growth-mindset treatment groups at Time 1.

Table 16

T1 Comparison of Means among Treatment Conditions

	Control		Growth Mindset		*t*	*df*	Sig (2-tailed) *p* = .05
	M	*SE*	*M*	*SE*			
T1 Incremental	5.18	0.08	5.09	0.08	0.886	167	*ns*
T1 Entity	2.12	0.09	2.13	0.09	-0.081	169	*ns*
T1 Intelligence Theory	4.97	0.08	4.95	0.08	0.157	171	*ns*
T1 Mastery-Approach	4.95	0.10	5.07	0.09	-0.896	171	*ns*
T1 Mastery-Avoidance	3.88	0.13	3.91	0.15	-0.179	172	*ns*
T1 Perform-Approach	4.81	0.10	4.77	0.12	0.245	169	*ns*
T1 Perform-Avoidance	4.67	0.12	4.73	0.13	-0.300	168	*ns*
T1 Reading Efficacy	6.34	0.14	6.61	0.17	-1.214	152	*ns*
T1 Strategy Use	2.07	0.07	2.02	0.08	0.391	170	*ns*
T1 Reading Skill	5.48	0.29	5.66	0.31	-0.442	166	*ns*
SAT-Reading	552.01	13.14	560.00	12.45	-0.441	144	*ns*
High-School GPA	3.54	0.04	3.56	0.04	-0.376	162	*ns*

The differences between learners' scores at Campus 1 and Campus 2 were analyzed with the *t*-test for two independent samples. Results are presented in Table 17. Two significant differences were observed. On average, Campus 1 participants reported using significantly more reading comprehension strategies than Campus 2 participants. Also, Campus 1 participants reported significantly higher SAT-Reading scores than Campus 2 participants.

Table 17

T1 Comparison of Means among Campus Sites

	Campus 1		Campus 2		*t*	*df*	Sig (2-tailed)
	M	*SE*	*M*	*SE*			*p* = .05
T1 Incremental	5.16	0.07	5.10	0.08	0.567	167	*ns*
T1 Entity	2.17	0.09	2.06	0.09	-0.838	169	*ns*
T1 Intelligence Theory	4.92	0.08	5.02	0.08	0.881	169.58	*ns*
T1 Mastery-Approach	5.03	0.09	4.97	0.10	0.447	171	*ns*
T1 Mastery-Avoidance	3.92	0.11	3.86	0.14	0.329	172	*ns*
T1 Perform-Approach	4.81	0.09	4.77	0.12	0.267	169	*ns*
T1 Perform-Avoidance	4.79	0.11	4.58	0.14	1.176	168	*ns*
T1 Reading Efficacy	6.35	0.15	6.62	0.16	-1.245	152	*ns*
T1 Strategy Use	2.15	0.07	1.91	0.09	2.247	170	.026
T1 Reading Skill	5.59	0.28	5.54	0.32	-0.116	166	*ns*
SAT-Reading	580.22	11.97	524.98	12.82	3.128	144	.002
High-School GPA	3.51	0.04	3.60	0.04	-1.618	162	*ns*

A series of one-way analysis of variance (ANOVA) tests were used to examine the differences between Time 1 scores among learners taught by each instructor. ANOVA results are presented in Table 18. There was no significant difference on Time 1 scores for learners taught by each instructor.

Table 18

T1 Comparison of Means by Instructor

	Instructor 1		Instructor 2		Instructor 3		*F*	*df*	*p*
	M	*SE*	*M*	*SE*	*M*	*SE*			
T1 Incremental	5.11	0.09	5.11	0.10	5.18	0.09	0.19	2, 166	*ns*
T1 Entity	2.11	0.11	2.20	0.12	2.05	0.10	0.50	2, 168	*ns*
T1 Intelligence Theory	5.00	0.09	4.85	0.11	5.04	0.09	1.07	2, 170	*ns*
T1 Mastery-Approach	5.11	0.10	4.92	0.11	4.99	0.12	0.73	2, 170	*ns*
T1 Mastery-Avoid	3.85	0.19	3.86	0.16	3.98	0.15	0.17	2, 171	*ns*
T1 Perform-Approach	4.84	0.14	4.84	0.12	4.68	0.13	0.49	2, 168	*ns*
T1 Perform-Avoid	4.57	0.16	4.89	0.13	4.61	0.16	1.39	2, 167	*ns*
T1 Reading Efficacy	6.74	0.18	6.24	0.21	6.44	0.18	1.79	2, 151	*ns*
T1 Strategy Use	1.93	0.10	2.18	0.09	2.02	0.10	1.85	2, 169	*ns*
T1 Reading Skill	5.69	0.37	5.49	0.35	5.54	0.37	0.08	2, 165	*ns*
SAT-Reading	537.59	15.67	577.39	16.18	552.08	14.83	1.65	2, 143	*ns*
High-School GPA	3.59	0.05	3.47	0.05	3.59	0.05	2.26	2, 161	*ns*

Time 2 Measures

Similar procedures to those described above were used for the analyses of the Time 2 measures. A notable number of invalid cases were identified among the strategy use ($n = 46$) and reading comprehension task ($n = 25$) responses. Common patterns among the invalid cases included participants skipping numerous items and giving responses that did not make sense. Table 19 provides a summary of the handling of T2 outliers for affected variables.

Outliers were treated as missing, except when the scale measured learners' performance on a task and learners' scores exceeded the range of what was expected in a normal distribution. When those two conditions existed, the scores were considered valid and were capped to normalize the distribution. In four instances, potential outliers were found where the cumulative percent exceeded the 5% typically found in a normal distribution (Field, 2015). This occurrence was identified among bridging strategy use, reading comprehension at textbase, reading comprehension bridging, and reading comprehension elaboration scores. Potential outliers among these variables were capped to normalize the data because they were valid scores learners had earned on the respective tasks. One earned score was treated as missing because it was a low outlying score. Raising the score to fall within the normal distribution would not be a valid representation of the earned score.

Descriptive statistics for Time 2 measures are presented in Table 20, which includes a summary of the distribution of the data, mean and standard deviation scores, and skewness and kurtosis statistics. Skewness and kurtosis were improved for all affected variables after invalid cases were omitted and outliers were removed or capped. Learners' use of elaboration and prediction strategies were excluded from the analyses because few learners used these strategies on the self-explanation task (n = 24 and n = 5, respectively). Student grade reports were excluded from these analyses due to the low level of consent: 43 students consented for the university to disclose their grades, 18 declined, and 113 did not respond.

Table 19

T2 Outliers

Variable	Extreme Outliers	Probable Outliers	Resolution
T2 Incremental	1	1	Missing
T2 Entity		1	Missing
T2 Mastery-Approach	1	-	Missing
T2 Perform-Approach	-	4	Missing
T2 Reading Efficacy	-	1	Missing
T2 Strategy Use		2	Capped
Paraphrase Strategy		2	Capped
Bridge Strategy	1	4/7*	Capped
Prior Knowledge	-	1	Capped
RC at Textbase		8*	Capped
RC Bridging		12*	Capped
RC Elaboration		1/10*	Capped
Total RC Score		1	Capped
T2 Reading Skill	1	1	Capped

Note. *Z*-scores were used to identify extreme ($z > 3.29$) and probable ($z > 2.58$) outliers. Outliers coded as missing are excluded from subsequent analyses. "Capped" means data were recoded to the highest score among data points within the range of the normal distribution (Osborne & Overbay, 2004). RC = reading comprehension.
* Indicates potential outliers ($z > 1.95$) that are treated as probable outliers because they represent more than 5% of the valid scores. 5% is higher than typically expected in a normal distribution (Field, 2015).

Table 20

Descriptive Statistics for Time 2 Variables

Variable	*N*	Min	Max	*M*	*SD*	Skewness	Std. Error	Kurtosis	Std. Error
T2 Incremental	159	3.00	6.00	4.99	.85	-.50	.19	-.64	.38
T2 Entity	160	1.00	5.00	2.36	1.09	.63	.19	-.33	.38
T2 Intelligence Theory	161	2.50	6.00	4.79	.93	-.44	.19	-.76	.38
T2 Mastery-Approach	160	2.00	6.00	4.67	1.02	-.41	.19	-.58	.38
T2 Mastery-Avoidance	160	1.00	6.00	4.07	1.29	-.25	.19	-.54	.38
T2 Perform-Approach	157	1.67	6.00	4.57	1.07	-.36	.19	-.45	.38
T2 Perform-Avoidance	161	1.00	6.00	4.31	1.40	-.67	.19	-.29	.38
T2 reading Efficacy	160	2.29	9.60	6.42	1.36	.10	.19	-.16	.38
T2 Strategy Use	122	1.00	31.00	14.39	7.44	.08	.22	-.73	.44
Paraphrase Strategy	122	1.00	26.00	12.99	6.65	-.04	.22	-.82	.44
Bridge Strategy	60	1.00	4.00	2.02	1.10	.61	.31	-1.04	.61
Prior Knowledge	164	0.00	9.50	4.35	2.09	.14	.19	-.61	.38
RC at Textbase	140	0.00	8.20	3.43	2.50	.34	.21	-1.01	.41
RC Bridging	138	0.00	6.00	2.43	1.92	.43	.21	-.89	.41
RC Elaboration	129	0.00	3.50	1.62	1.00	.24	.21	-.61	.42
Total RC Score	142	0.00	19.00	7.40	4.52	.48	.20	-.49	.40
T2 Reading Skill	160	0.00	11.00	5.63	2.29	.03	.19	-.37	.38

Note. Intelligence Theory is the summed entity beliefs and reverse-scored incremental beliefs scales (low score is extreme entity and high score is extreme incremental). RC = reading comprehension.

Correlational data among the Time 2 variables are provided in Table 21. Few moderate and strong correlations were observed among the Time 2 variables. The correlations among intelligence beliefs, the four achievement goals and reading efficacy beliefs with other Time 2 variables were weak, falling below $r = .30$.

As expected, mastery-approach goals was positively related to incremental beliefs ($r = .38$, $p < 0.01$) and negatively related to entity beliefs ($r = -.36$, $p < 0.01$). In addition, reading efficacy beliefs was positively related to incremental beliefs ($r = .32$, $p < 0.01$) and negatively related to entity beliefs ($r = -.35$, $p < 0.01$). Incremental beliefs was positively related to textbase reading comprehension ($r = .17$, $p < 0.05$) while entity beliefs was negatively related to textbase reading comprehension ($r = -.20$, $p < 0.05$) and total reading comprehension ($r = -.22$, $p < 0.05$). Finally, moderate correlations were observed between the three reading comprehension strategy use variables and reading comprehension textbase and total scores.

Several unexpected correlations were also observed. Similar to Time 1 correlations, performance-approach goals was positively related to incremental beliefs ($r = .31$, $p < 0.01$). Time 2 performance-avoidance goals was also positively related to incremental beliefs ($r = .17$, $p < 0.05$). In addition, entity beliefs was negatively related to performance-approach ($r = -.28$, $p < 0.01$) and performance-avoidance goals ($r = -.18$, $p < 0.05$). Finally, the three strategy use variables were unrelated to intelligence beliefs, reading efficacy and the four motivational variables.

Multicollinearity was apparent between Time 2 incremental and entity beliefs ($r = -.71$, $p < 0.01$). Following the same procedure used for the Time 2 measure, a composite Time 2 intelligence theory variable was formed.

Multicollinearity was also apparent between strategy use and paraphrase strategy ($r = .98$, $p < 0.001$), reading comprehension at the textbase and total reading comprehension ($r = .83$, $p < 0.001$), and reading comprehension bridging and total reading comprehension ($r = .80$, $p < 0.001$).

Correlational data among Time 1 and Time 2 variables are provided in Table 22. Corresponding variables measured at Time 1 and Time 2 shared moderate correlations ranging from $r = .42$ to $r = .55$. All other correlations was weak. Unexpectedly, Time 1 reading efficacy beliefs and the four achievement goals were unrelated to the three Time 2 reading comprehension strategy use variables.

The weak and non-significant correlations observed in the data casts doubt on whether the mediation analysis will yield significant results. For instance, the causal steps approach to mediation requires that significant relationships exist between (1) the independent variable and dependent variable, (2) the independent variable and mediator variable, and (3) the mediator variable and the dependent variable (Field, 2015). These data do not meet the criteria for the causal steps approach to mediation. Another approach to testing the significance of a mediating variable is the product of coefficients method (MacKinnon, Fairchild & Fritz, 2007). This method is not bound by the requirement that the three significant relationships exist. Rather, the product of the coefficients method assesses the significance of the mediating variable by first estimating the effect of the independent variable on the mediator variable and the effect of the mediator variable on the dependent variable. Second, the product of the two coefficients is divided by the corresponding standard error and the significance is determined by bootstrap resampling. Consequently, the product of coefficients method can be used for the mediational analysis of these data.

Table 21

T2 Correlations

Variable	1	2	3	4	5	6	7	8
1. T2 Incremental	-							
2. T2Entity	$-.714^{**}$	-						
3. T2Intelligence Theory	$.901^{**}$	$-.927^{**}$	-					
4. T2Mastery-Approach	$.384^{**}$	$-.358^{**}$	$.383^{**}$	-				
5. T2 Mastery-Avoidance	.120	-.155	.155	$.415^{**}$	-			
6. T2Perform-Approach	$.307^{**}$	$-.279^{**}$	$.302^{**}$	$.663^{**}$	$.291^{**}$	-		
7. T2Perform-Avoidance	$.173^{*}$	$-.178^{*}$	$.191^{*}$	$.375^{**}$	$.446^{**}$	$.600^{**}$	-	
8. T2Reading Efficacy	$.317^{**}$	$-.354^{**}$	$.335^{**}$	$.279^{**}$	.041	$.212^{**}$	.072	-
9. T2Strategy Use	.120	-.141	.135	-.064	-.165	-.036	-.079	.148
10. Paraphrase Strategy	.112	-.15	.114	-.072	-.180	-.024	-.082	.140
11. Bridge Strategy	-.138	.152	-.153	-.114	-.005	-.086	.062	.107
12. Prior Knowledge	$.250^{**}$	$-.245^{**}$	$.237^{**}$	.067	-.088	.042	-.060	$.293^{**}$
13. RC at Textbase	$.170^{*}$	$-.201^{**}$	$.205^{*}$	.075	-.099	.050	-.117	.061
14. RC Bridge	.146	-.169	.164	.016	-.073	-.046	-.033	$.230^{**}$
15. RC Elaboration	.045	-.033	.045	-.142	-.061	-.096	-.085	.015
16. Total RC Score	.155	$-.215^{*}$	$.205^{*}$	.001	-.102	-.087	-.081	$.172^{*}$
17. T2Reading Skill	.101	-.007	.015	.032	.019	.080	.153	$.182^{*}$

Table 21 (*continued*)

Variable	9	10	11	12	13	14	15	16	17
9. T2Strategy Use	-								
10. Paraphrase Strategy	.979**	-							
11. Bridge Strategy	.555**	.430**	-						
12. Prior Knowledge	.433**	.420**	.286*	-					
13. RC at Textbase	.467**	.442**	.469**	.244**	-				
14. RC Bridge	.463**	.396**	.452**	.412**	.447**	-			
15. RC Elaboration	.422**	.402**	.233	.340**	.285**	.310**	-		
16. Total RC Score	.583**	.518**	.583**	.415**	.831**	.803**	.548**	-	
17. T2Reading Skill	.204*	.233*	-.013	.147	-.046	.059	.189*	.073	-

Note. Intelligence Theory is the summed entity beliefs and reverse-scored incremental beliefs scales (low score is extreme entity and high score is extreme incremental). RC means reading comprehension.
*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table 22

T2 by T1 Correlations

Variable	T1 Incremental	T1 Entity	T1 Intelligence Theory	T1 Mastery-Approach	T1 Mastery -Avoid	T1 Perform-Approach	T1 Perform-Avoid	T1 RC Efficacy	T1 Strategy Use	T1 Reading Skill	High-School GPA	SAT-Reading
T2 Incremental	.490**	-.357**	.501**	.158*	-.007	.190*	.160*	.166*	-.070	.015	-.046	.060
T2 Entity	-.380**	.415**	-.459**	-.154	-.065	-.144	-.165*	-.232**	.066	-.011	-.121	.012
T2 Intelligence Theory	.431**	-.393**	.482**	.152	.025	.150	.157*	.162	-.085	.005	.018	.011
T2 Mastery-Approach	.257**	-.211**	.301**	.532**	.225**	.322**	.305**	.078	-.043	-.056	-.001	.027
T2 Mastery-Avoid	.072	-.130	.124	.302**	.424**	.106	.191*	-.024	.003	-.036	.074	.002
T2 Perform-Approach	.116	-.099	.109	.289**	.205**	.486**	.444**	.059	-.093	.005	.005	.041
T2 Perform-Avoid	.072	-.054	.041	.177*	.300**	.371**	.443**	-.028	-.034	-.057	-.090	.050
T2 RC Efficacy	.248**	-.166*	.215**	.202*	.000	.165*	.099	.549**	.032	.088	.091	.068
T2 Strategy Use	.074	-.053	.049	-.104	-.077	-.054	-.093	.112	.126	.148	.001	.110
Paraphrase Strategy	.090	-.070	.056	-.096	-.072	-.060	-.066	.118	.076	.153	-.022	.122
Bridge Strategy	-.138	.244	-.183	-.082	-.137	.042	-.140	.113	.311*	.079	.007	-.068
Prior Knowledge	.058	-.107	.111	-.138	-.045	-.046	.001	.339**	.067	.245**	.093	.054
RC at Textbase	.060	-.066	.112	-.124	-.140	-.123	-.207*	.015	.206*	.006	-.035	.117
RC Bridging	-.102	.070	-.009	-.060	.065	-.032	.007	.232**	.147	.105	-.012	.105
RC Elaboration	-.048	-.017	-.040	-.206*	.003	-.181*	-.035	.003	.168	.236**	-.014	.121
Total RC Score	-.025	-.009	.043	-.117	-.015	-.120	-.130	.123	.226**	.132	-.016	.175
T2 Reading Skill	-.011	-.010	.015	.059	.129	.090	.112	.188*	.154	.241**	.024	.096

Note. *Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

The differences between scores at Time 2 for the control and growth-mindset treatment conditions were analyzed with the *t*-test for two independent samples. Results are presented in Table 23. One significant difference was observed. On average, control group learners earned significantly higher scores for textbase reading comprehension than learners assigned to the growth-mindset treatment group. There were no other statistical differences between participants assigned to the control and growth-mindset treatment conditions at Time 2.

The differences between learners' scores at Campus 1 and Campus 2 were analyzed with the *t*-test for two independent samples. Results are presented in Table 24. There was no statistical difference in learners' scores at Campus 1 and Campus 2 at Time 2.

A series of one-way ANOVAs was used to examine the differences between Time 2 scores among learners taught by each instructor. ANOVA results are presented in Table 25. There was no statistical difference on Time 2 scores for learners taught by each instructor.

Table 23

T2 Comparison of Means among Treatment Conditions

	Control		Growth-Mindset		*t*	*df*	Sig (2-tailed)
	M	*SE*	*M*	*SE*			*p* = .05
T2 Incremental	5.02	0.09	4.97	0.10	0.379	157	*ns*
T2 Entity	2.43	0.11	2.28	0.13	0.863	158	*ns*
T2 Intelligence Theory	4.78	0.10	4.79	0.11	-0.078	159	*ns*
T2 Mastery-Approach	4.76	0.11	4.57	0.12	1.149	158	*ns*
T2 Mastery-Avoid	4.00	0.14	4.14	0.15	-0.704	158	*ns*
T2 Perform-Approach	4.66	0.11	4.46	0.13	1.188	155	*ns*
T2 Perform-Avoid	4.38	0.13	4.23	0.18	0.665	139.38	*ns*
T2 RC Efficacy	6.41	0.14	6.44	0.17	-0.124	158	*ns*
T2 Strategy Use	14.28	0.94	14.54	0.96	-0.189	120	*ns*
Paraphrase Strategy	12.94	0.85	13.06	0.85	-0.094	120	*ns*
Bridge Strategy	2.13	0.22	1.90	0.18	0.818	58	*ns*
Prior Knowledge	4.28	0.23	4.44	0.23	-0.486	162	*ns*
RC at Textbase	3.87	0.29	2.92	0.29	2.277	138	.02
RC Bridging	2.62	0.23	2.22	0.23	1.233	136	*ns*
RC Elaboration	1.46	0.12	1.80	0.12	-1.926	127	*ns*
Total RC Score	7.90	0.51	6.82	0.56	1.423	140	*ns*
T2 Reading Skill	5.36	0.25	5.96	0.26	-1.670	158	*ns*

Table 24

T2 Comparison of Means among Campus Sites

	Campus 1		Campus 2		*t*	*df*	Sig (2-tailed)
	M	*SE*	*M*	*SE*			*p* = .05
T2 Incremental	5.01	0.09	4.97	0.10	0.305	157	*ns*
T2 Entity	2.38	0.11	2.33	0.14	0.296	158	*ns*
T2 Intelligence Theory	4.80	0.10	4.76	0.11	0.283	159	*ns*
T2 Mastery-Approach	4.73	0.11	4.59	0.11	0.852	149.31	*ns*
T2 Mastery-Avoid	4.07	0.14	4.07	0.15	-0.017	158	*ns*
T2 Perform-Approach	4.61	0.12	4.50	0.12	0.640	155	*ns*
T2 Perform-Avoid	4.29	0.15	4.34	0.16	-0.204	159	*ns*
T2 RC Efficacy	6.41	0.13	6.45	0.18	-0.174	158	*ns*
T2 Strategy Use	15.13	0.94	13.21	0.89	1.484	115.74	*ns*
Paraphrase Strategy	13.65	0.83	11.94	0.82	1.394	120	*ns*
Bridge Strategy	2.03	0.19	2.00	0.22	0.092	58	*ns*
Prior Knowledge	4.48	0.22	4.16	0.25	0.963	162	*ns*
RC at Textbase	3.61	0.28	3.15	0.32	1.066	138	ns
RC Bridging	2.51	0.21	2.32	0.26	0.572	136	*ns*
RC Elaboration	1.59	0.11	1.66	0.14	-0.417	127	*ns*
Total RC Score	7.65	0.48	7.02	0.61	0.814	140	*ns*
T2 Reading Skill	5.55	0.23	5.76	0.29	-0.581	158	*ns*

Table 25

T2 Comparison of Means by Instructor

	Instructor 1		Instructor 2		Instructor 3		*F*	*df*	*p*
	M	*SE*	*M*	*SE*	*M*	*SE*			
T2 Incremental	4.98	0.11	5.10	0.11	4.88	0.13	0.95	2, 156	*ns*
T2 Entity	2.45	0.17	2.41	0.14	2.23	0.14	0.60	2, 157	*ns*
T2 Intelligence Theory	4.72	0.13	4.83	0.12	4.79	0.13	0.16	2, 158	*ns*
T2 Mastery-Approach	4.67	0.13	4.78	0.14	4.55	0.14	0.75	2, 157	*ns*
T2 Mastery-Avoid	4.04	0.19	3.92	0.17	4.26	0.18	1.00	2, 157	*ns*
T2 Perform-Approach	4.42	0.15	4.77	0.13	4.47	0.16	1.70	2, 154	*ns*
T2 Perform-Avoid	4.17	0.20	4.54	0.16	4.17	0.22	1.35	2, 158	*ns*
T2 RC Efficacy	6.31	0.21	6.46	0.17	6.48	0.18	0.23	2, 157	*ns*
T2 Strategy Use	12.66	1.04	16.17	1.11	13.77	1.25	2.52	2, 119	*ns*
Paraphrase Strategy	11.66	0.97	14.75	0.99	12.03	1.09	2.89	2, 119	*ns*
Bridge Strategy	1.73	0.27	2.26	0.24	1.95	0.23	1.11	2, 57	*ns*
Prior Knowledge	3.96	0.28	4.70	0.27	4.31	0.30	1.77	2, 161	*ns*
RC at Textbase	3.13	0.36	3.88	0.35	3.15	0.39	1.49	2, 137	*ns*
RC Bridging	2.20	0.29	2.79	0.28	2.24	0.27	1.43	2, 135	*ns*
RC Elaboration	1.64	0.16	1.66	0.14	1.54	0.16	0.19	2, 126	*ns*
Total RC Score	6.84	0.70	8.18	0.59	6.95	0.71	1.38	2, 139	*ns*
T2 Reading Skill	5.89	0.33	5.46	0.31	5.60	0.30	0.49	2, 157	*ns*

Missing Data Analyses

Descriptive statistics for Time 1 and Time 2 showed that there was a substantial amount of missing data. In some cases, learners did not complete the surveys. In other cases, responses were invalid because they contained gibberish or they did not pertain to the task at hand. The SPSS program, *Missing Value Analysis,* was used to examine the missing data to determine its impact on analyses. Table 26 provides a summary of the missing data.

Table 26

Summary of Missing Data

	N	Missing	
		Count	Percent
T1 Incremental	169	5	2.9
T1 Entity	171	3	1.7
T1 Intelligence Theory	173	1	0.6
T1 Mastery-Approach	173	1	0.6
T1 Mastery-Avoid	174	0	0
T1 Perform-Approach	171	3	1.7
T1 Perform-Avoid	170	4	2.3
T1 RC Efficacy	154	20	11.5
T1 Strategy Use	172	2	1.1
T1 Reading Skill	168	6	3.4
High School GPA	164	10	5.7
SAT-Reading	146	28	16.1
T2 Incremental	159	15	8.6
T2 Entity	160	14	8
T2 Intelligence Theory	161	13	7.5
T2 Mastery-Approach	160	14	8
T2 Mastery-Avoid	160	14	8
T2 Perform-Approach	157	17	9.8
T2 Perform-Avoid	161	13	7.5
T2 RC Efficacy	160	14	8
T2 Strategy Use	122	52	29.9
Paraphrase Strategy	122	52	29.9
Bridge Strategy*	60	114	65.5
Prior Knowledge	164	10	5.7
RC at Textbase	140	34	19.5
RC Bridging	138	36	20.7
RC Elaboration	129	45	25.9
Total RC Score	142	32	18.4
T2 Reading Skill	160	14	8

Note. *Missing count is mostly reflective of learners not using the strategy.

The pattern of missing data was explored to determine whether data were missing completely at random (MCAR analysis). The missing value program's MCAR analysis produces a chi-square statistic called Little's MCAR, which if non-significant, indicates that the data were missing at random. The missing value MCAR analysis for this research indicates that the data were not missing at random (Little's MCAR = 1089.258, $df = 941$, $p = .001$).

The data were explored by treatment condition, campus site, and instructor to determine if any patterns existed. On average, learners in the growth-mindset treatment condition had more missing surveys ($M = 2.33$, $SD = 3.77$) than learners in the control group ($M = 1.2$, $SD = 2.24$). The differences between the mean missing data scores for the growth-mindset treatment and control conditions were analyzed with the *t*-test for two independent samples. Results for Levene's test showed that the variances for both groups were not equal; therefore, the assumption of homogeneity of variance was violated ($F = 12.01$, $p = .001$). Results for the independent samples *t*-test where equal variances were not assumed showed that with regard to the amount of missing data, there was a significant difference between learners in the growth-mindset treatment group and those assigned to the control group condition ($t(133.37) = -2.37$, $p = .02$).

The difference in missing surveys was also observed by campus. On average, learners at Campus 2 had more missing surveys ($M = 2.71$, $SD = 4.24$) than learners at Campus 1 ($M = 1.03$, $SD = 1.54$). The differences between the mean missing data scores on each campus were analyzed with the *t*-test for two independent samples. Results for Levene's test showed that the variances for both campus locations were not equal; therefore, the assumption of homogeneity of variance was violated ($F = 39.92$, $p < .001$). Results for the independent samples *t*-test where equal variances were not assumed showed that with regard to the amount of missing data, there was a significant difference between learners at Campus 2 and those at Campus 1 ($t(88.795) = -3.27$, $p < .01$).

On average, most of the missing data were attributed to learners in Instructor 1's courses ($M = 2.86$, $SD = 4.40$), followed by Instructor 3's courses ($M = 1.68$, $SD = 2.82$), and then Instructor 2's courses ($M = 0.80$, $SD = 0.87$). A one-way ANOVA was used to examine the differences in missing data among learners taught by each instructor. ANOVA results showed a significant difference in the amount of missing data among learners taught by each instructor (*Brown-Forsythe* (2, 98.564) = 6.52, $p < .01$). Results for the robust tests of equality of means (*Brown-Forsythe* statistic) are presented because Levene's test showed that the assumption of homogeneity of variance was violated (F (2, 171) = 21.12, $p < .001$). This violation was most likely due to the large difference in mean and standard deviation values.

Planned comparisons were conducted using contrast coefficients to test the following conditions: (a) whether Instructor 1 was different from Instructors 2 and 3 with regard to missing data, and (b) if Instructors 2 Instructor 3 differed from each other with regard to missing data. For the first contrast, Instructor 1 was given a weight of -2, while Instructors 2 and 3 were given a weight of 1 each. For the second contrast, Instructor 3 was given a weight of -1 and Instructor 2 was given a weight of 1. Using the results that did not assume equal variances, the contrasts test showed that with regard to missing data, learners in Instructor 1's courses differed significantly from learners in the other instructors' courses ($t(67.053) = -2.61$, $p = .01$). In addition, with regard to missing data, leaners in Instructor 3's courses differed significantly from learners in Instructor 2's courses ($t(65.989) = -2.26$, $p = .03$).

Growth-Mindset Fidelity

Learners were randomly assigned to either the growth-mindset treatment or control group conditions after all participant consent forms were received. Two hours before the second class meeting, learners were sent a secure link to the respective treatment condition materials through Qualtrics. One password was used for both portals, and the password to access the materials was provided at the start of class. Learners were asked not to discuss anything they learned during the activity with their peers so that everyone's responses would reflect their own thinking throughout the research process.

Two procedures were put in place to test the fidelity of the growth-mindset intervention and reinforce the content from the growth-mindset treatment condition. First, learners were asked to summarize the scientific ideas they had learned from the respective treatment materials. Learners' summaries were analyzed to ensure they understood the materials and to check for cross-treatment contamination.

Twenty-two specific references were generated from the information presented in the growth-mindset video and research article and 29 specific references were derived from the information presented in the control group video and article.

All learners' summaries were assessed for the quality and number of unique growth-mindset references included in their responses. A score of zero was assessed for inaccurate and off-topic responses. One point was assessed for vague references to any of the ideas. Two points were assessed for each accurate description, explanation, or example of one of the specific references and its connection to growth mindsets. In addition, learners' responses were assessed to see if they contained any of the specific references generated from the information presented to the control group.

Of the 84 learners in the growth-mindset treatment condition, three earned a score of zero. In each instance, the learner's brevity did not provide sufficient information to assess whether they did or did not understand the materials. For example, one learner wrote, "I've learned that your brain controls everything and is always changing."

Ten learners earned a score of one. Examination of their responses showed that they mentioned a scientific concept from the materials, but they did not extend the idea to provide a description, explanation, or example of its connection to growth mindsets. For instance, one learner wrote, "It is a good idea to write things down several times in order to memorize it."

All other learners in the growth-mindset treatment group scored two to ten points on the exercise by providing one or more accurate descriptions, explanations, or examples of the connection between specific scientific references and the growth mindset. One learner who earned a two on his or her response wrote, "It is possible to challenge your brain by reading and practicing your literature skills. You can increase your academic abilities by being persistent in your skills. A lot of people do not challenge themselves like they should. They are content with their current IQ." One learner who earned a score of 10 wrote the following passage:

> There are two mindsets that people can have. One is a fixed mindset and the other is a growth mindset. The fixed mindset results from believing that your abilities come from birth, and not from learning and persistence. People like this are more likely to quit early when things seem hard. They also focus more on proving

> themselves rather than learning difficult things. The growth mindset is the better of the two. This puts a focus on the ability to learn anything, nothing is beyond your reach. This mindset encourages completing difficult tasks with persistence and dedication.

No learners in the growth-mindset treatment group mentioned any of the specific references generated from the content of the control group materials.

All learners in the control group condition provided summaries that were consistent with the materials for the control treatment condition. All learners in the control group earned a score of zero on this task, as they did not mention any of the specific references generated from the growth-mindset materials. No evidence of cross-treatment contamination was found in growth-mindset or control group learner summaries of their respective treatment conditions.

The second procedure to test the fidelity and reinforce the content of the growth-mindset intervention was to have learners write a letter of advice to a struggling high-school learner. The principal investigator and Coder 2 assessed learners' letters using the following procedure. Coder 2 was trained on the coding guide using the specific references that were generated from the materials presented in the growth-mindset treatment and control conditions. Eleven additional growth-mindset codes were agreed upon by the coders during the coding process based upon the content of learners' letters.

The following scheme was used to grade learners' letters: 0 for a response that gave advice but made no reference to growth-mindset concepts, 1 for a response that vaguely mentioned or eluded to growth-mindset beliefs but did not discuss specific characteristics of the growth mindset, 2 for a response that gave advice including specific references to growth mindset and that described one or two characteristics of the growth mindset, and 3 for a response that gave advice including specific references to growth mindset and that described three or more characteristics of the growth mindset. Interrater agreement was almost perfect (Kappa = .949).

An independent samples *t*-test was used to compare growth-mindset and control group learners' use of growth-mindset references in letters to struggling high-school learners. Learners in the control group communicated significantly fewer growth-mindset references to the struggling learner ($M = 0.61$, $SE = 0.10$) than learners in the growth-mindset treatment condition ($M = 2.27$, $SE = 0.09$, $t(172) = -12.413$, $p < .001$, $d = 1.882$). On average, the groups differed in terms of their communication of growth-mindset ideas by almost two standard deviations, which adds credence to the fidelity of the intervention.

In addition, the letters to struggling high-school learners were used to validate comprehension of the treatment condition materials by the aforementioned learners in the growth-mindset treatment condition who scored 0 or 1 on the summary exercise. Review of the respective letters showed that the learners earned scores ranging from 1 to 3. Therefore, despite the extreme brevity of their summaries, the content of their letters suggested that they understood the main points of the treatment materials.

A third procedure was used to assess the ongoing fidelity of the growth-mindset intervention. Learners were asked to respond to a five-minute quick-write prompt to describe the advice they would give a peer who was struggling academically and contemplating dropping out of college. Two coders, including the principal investigator, assessed learners' responses. The second coder was trained on the coding guide using the specific references that were generated from the materials presented in the growth-mindset treatment condition. Nine additional growth-mindset codes were agreed upon by the coders during the coding process based upon the content of learners' responses.

The following scheme was used to grade learners' letters of advice to a struggling peer: 0 for a response that gave advice but made no reference to growth-mindset concepts, 1 for a response that vaguely mentioned or eluded to growth-mindset beliefs but did not discuss specific characteristics of the growth mindset, 2 for a response that gave advice including a specific reference to a growth-mindset concept, 3 for a response that gave advice including two specific references to a growth-mindset concept, 4 for a response that gave advice including three specific references to a growth-mindset concept, and so on. Interrater agreement was substantial (Kappa = .738).

An independent samples *t*-test was used to compare growth-mindset and control group learners' use of growth-mindset references in letters of advice to a struggling peer. Learners in the control group communicated significantly fewer growth-mindset references to the struggling peer ($M = 0.61$, $SE = 0.11$) than learners in the growth-mindset treatment condition ($M = 1.59$, $SE = 0.21$, $t(97.141) = -4.158$, $p < .001$, $d = 0.715$). On average, the groups differed in terms of their communication of growth-mindset ideas by almost three quarters of a standard deviation. In addition, while the number of growth-mindset references made by learners in the growth-mindset treatment group reduced over time, the number of growth-mindset references made by learners in the control group remained relatively stable. These findings indicate that there was no diffusion of the growth-mindset treatment information to the control group and that the fidelity of the intervention was sustained.

The effect of the growth-mindset on learners' implicit theories about intelligence was also examined. SPSS split files by treatment condition and paired samples *t*-tests were used to compare pretest and posttest intelligence theory scores for each group. Control group learners' implicit beliefs were significantly more entity-oriented at Time 2 than at Time 1. At Time 2, on average, learners in the control group had significantly lower intelligence theory beliefs ($M = 4.79$, $SE = 0.10$) than they had at Time 1 ($M = 4.97$, $SE = 0.08$, $t(85) = 2.010$, $p = .05$, 95% BCa [0.002, 0.349], $d = .21$). Similarly, at Time 2, learners in the growth-mindset treatment group had lower intelligence theory beliefs ($M = 4.79$, $SE = 0.11$) than they had at Time 1 ($M = 5.01$, $SE = 0.08$, $t(73) = 1.968$, $p = .05$, 95% BCa [-0.003, 0.435]). Although on average the growth-mindset group's implicit beliefs about intelligence were more entity-oriented at Time 2 than at Time 1, the difference was not significant. Tables 27 and 28 summarize the group means and results from the paired samples *t*-tests, respectively.

Examination of group means for incremental beliefs showed that both groups declined in incremental beliefs and increased in entity beliefs at Time 1 compared to Time 2. Entity beliefs appeared to be the defining factor. On average, the control group reported significantly higher entity beliefs at Time 2 ($M = 2.42$, $SE = 0.12$) compared to Time 1 ($M = 2.13$, $SE = 0.09$, $t(84) = -2.528$, $p = .01$, 95% BCa [-0.513, -0.061]). This represents a small effect ($d = .30$). Although on average the growth-mindset group also reported higher entity beliefs at Time 2 ($M = 2.26$, $SE = 0.13$) compared to Time 1 ($M =$

2.08, *SE* = 0.09, *t*(71) = -2.528, *p* = .15, 95% BCa [-0.438, 0.070]), the difference was not significant.

Table 27

Mean Implicit Intelligence Beliefs Scores by Treatment Condition

Treatment		*M*	*N*	Std. Deviation	Std. Error Mean
Control Group					
	T1 Incremental	5.22	82	0.691	0.076
Pair 1	T2 Incremental	5.09	82	0.789	0.087
	T1 Entity	2.13	85	0.843	0.091
Pair 2	T2 Entity	2.42	85	1.075	0.117
	T1 Intelligence Theory	4.97	86	0.780	0.084
Pair 3	T2 Intelligence Theory	4.79	86	0.914	0.099
Growth-Mindset Group					
	T1 Incremental	5.13	72	0.65809	0.078
Pair 1	T2 Incremental	4.99	72	0.85783	0.101
	T1 Entity	2.08	72	0.78905	0.093
Pair 2	T2 Entity	2.26	72	1.11838	0.132
	T1 Intelligence Theory	5.01	74	0.720401	0.084
Pair 3	T2 Intelligence Theory	4.79	74	0.96321	0.112

Table 28

Paired Samples Test Results for T1 and T2 Intelligence Beliefs by Treatment Condition

Treatment		Paired Differences *M*	Std. Deviation	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
Control Group							
Pair 1	T1 - T2 Incremental	0.131	0.761	0.084	1.56	81	.12
Pair 2	T1 - T2 Entity	-0.287	1.047	0.114	-2.528	84	.01
Pair 3	T1 - T2 Intelligence Theory	0.175	0.809	0.087	2.01	85	.05
Growth-Mindset Group							
Pair 1	T1 - T2 Incremental	0.135	0.776	0.091	1.481	71	.14
Pair 2	T1 - T2 Entity	-0.184	1.080	0.127	-1.446	71	.15
Pair 3	T1 - T2 Intelligence Theory	0.216	0.945	0.110	1.968	73	.05

iSTART Fidelity

Learners were introduced to iSTART at the beginning of the first computer lab session. Learners were shown how to log in and navigate the system by the principal investigator using a computerized classroom projection system. Using desktop computers, learners were able to set up their passwords and access iSTART screens where tutorials, assignments, games, and progress reports would be displayed. Learners were unable to access iSTART tutorials or activities at this time.

Learners were given access to iSTART tutorials at the end of the second class meeting (i.e., after the growth-mindset intervention). The principal investigator remained in the computer lab after class to answer questions and guide those who wanted assistance accessing iSTART. During these extended stays at both campus locations, it was discovered that some of the computers were in need of system updates. Some computers crashed mid-session while others failed to load the iSTART tutorials. With the help of the instructors, the researcher found an alternative browser that enabled all students to access the website. As a result of these technical difficulties, Week 4 of the research was delayed by one week for all classes. After the delay, the research schedule, including iSTART training, continued as planned and ended one week later than initially scheduled.

Learners were asked to complete the iSTART tutorial, which included eight training videos and one guided self-explanation text, and to practice using iSTART strategies independently on four practice texts. Learners were also encouraged to try using the strategies in other courses. All of these tasks were to be completed outside of class time. Instructors allowed students to work on iSTART during the class meeting time if they had completed their assigned coursework for the day.

One hundred sixty-three learners (93.7%) completed the iSTART tutorial. Three learners did not complete any of the training modules and eight learners completed between 12 and 87% of the training. Learners who did not complete the tutorial were equitably disbursed across the treatment conditions, campuses, and instructors. Learners' progress on the iSTART tutorial were binary coded to represent their status as incomplete (0) or complete (1) with regard to iSTART training. Crosstabs and Pearson's chi-square statistic were used to test proportional differences in learners' status with regard to the treatment condition, campus location, and instructor. Fisher's exact test is reported in instances where the expected cell count was fewer than five in one or more of the cells.

There was no significant association between whether or not learners completed the iSTART tutorial and the following variables:

- Treatment condition (χ^2 (1) = 0.185, p = .67)
- Campus location (p = .211, 2-sided Fisher's exact test)
- Instructor (p = .682, 2-sided Fisher's exact test).

One hundred twenty-eight learners (73.6%) completed the self-explanation of the four assigned practice texts. Thirty-two learners did not complete work on any of the assigned practice texts, nine learners worked on one text, and five learners worked on three texts. Sixty-seven learners (74.4%) in the control group and 61 learners (72.6%) in the growth-mindset treatment group completed all assignments. Crosstabs and Pearson's chi-square statistic were used to test proportional differences in learners' completion of the four assignments with regard to their treatment condition, campus location, and instructor.

The association between whether learners completed work on the four practice texts or not by treatment condition was not significant ($\chi 2$ (1) = 0.074, p = .79).

There was a significant association between whether or not learners completed the self-explanations of the four assigned texts and the following variables:

- Campus location (χ^2 (1) = 12.469, $p < .001$, Cramer's $V = 0.27$, $p < .001$), which represents a small effect
- Instructor (χ^2 (2) = 21.900, $p < .001$, Cramer's $V = 0.36$, $p < .001$), which represents a medium effect.

Learners' responses to two qualitative survey items were examined to determine whether they had independently practiced the iSTART reading comprehension strategies. First, after the second practice text was scheduled to be completed, learners were sent a five-minute timed electronic survey about their use of iSTART reading comprehension strategies in other courses. One hundred fifty-eight learners completed the survey, while 16 did not.

Learner responses were binary coded to reflect whether they had tried the strategies in other courses (1 if they did and 0 if they did not). Four responses were excluded because the responses were unrelated to iSTART. Most learners (n = 84) reported trying iSTART in other courses. However, a substantial portion (44%, n = 70) reported that they had not tried iSTART in other courses. SPSS crosstab function and

Pearson's chi-square were used to test the association between learners' use of the iSTART strategies in other courses and the following categorical predictors: (1) treatment condition, (2) campus, and (3) instructor.

There was no significant association between whether or not learners reported using iSTART strategies in other courses at the first check-in and the following variables:

- Learners' treatment condition assignment (χ^2 (1) = 0.008, p =.93)
- Learners' campus site (χ^2 (1) = 1.805, p =.18)

The association between learners' instructors and whether or not they used iSTART strategies at the first check-in was significant (χ^2 (2) = 12.080, $p < .01$). This represented a small effect (Cramer's V = 0.28, $p < .01$). Learners in Instructor 2's courses constituted 50% of all learners who reported not using iSTART in other courses while learners in Instructor 3's courses constituted 42% of all learners who reported that they did try iSTART strategies in other courses. Table 29 displays these cross-tabulation results in detail.

Table 29

Learners' Use of iSTART in Courses at First Check-In by Instructor

Course Instructor		Used iSTART in Courses		Total
		Not Used	Strategies Used	
Instructor1	Count	19_a	29_a	48
	% within Instructor	39.6%	60.4%	100.0%
	% within Used iSTART in Courses (column)	27.1%	34.5%	31.2%
	% of Total Count (N = 154)	12.3%	18.8%	31.2%
Instructor2	Count	35_a	20_b	55
	% within Instructor	63.6%	36.4%	100.0%
	% within Used iSTART in Courses (column)	50.0%	23.8%	35.7%
	% of Total Count (N = 154)	22.7%	13.0%	35.7%
Instructor3	Count	16_a	35_b	51
	% within Instructor	31.4%	68.6%	100.0%
	% within Used iSTART in Courses (column)	22.9%	41.7%	33.1%
	% of Total Count (N = 154)	10.4%	22.7%	33.1%
Total	Count	70	84	154
	% within Instructor	45.5%	54.5%	100.0%

Note. Each subscript letter denotes a subset of Used iSTART in Courses - T1 categories whose column proportions do not differ significantly from each other at the .05 level.

A second qualitative survey was administered after the final reading task to inquire about learners' use of iSTART reading comprehension strategies in other courses. One hundred fifty-eight learners completed the survey while 16 did not. Learners were asked to list all the classes they were taking and to identify the strategies they used in each class. First, learners' independent practice of iSTART strategies in other courses was assessed by binary coding, so that 1 reflected strategy use and 2 reflected no strategy use. Crosstabs and Pearson's chi-square statistic were used to test proportional differences in learners' iSTART strategy use in other courses at the second check-in by treatment condition, campus location, and instructor.

There was no significant association between whether or not learners used iSTART strategies in other courses and treatment condition (χ^2 (1) = 1.657, p = .26). However, there was a significant association between whether or not learners used iSTART strategies in other courses at the second check-in and campus location (χ^2 (1) = 8.542, p < .01, Cramer's V = 0.22, p < .01.). One hundred sixteen learners reported using iSTART in other courses at the second check-in and 58 reported they had not. Almost 60% of the learners who reported not using iSTART strategies in other courses attended Campus 2 while almost 65% of the learners who did use the iSTART strategies in other courses attended Campus 1. Crosstab results for these findings are summarized in Table 30.

There was also a significant association between whether or not learners used iSTART strategies in other courses at the second check-in and instructor (χ^2 (1) = 10.359, p < .01, Cramer's V = 0.24, p < .01). Whereas approximately 75% of the learners in Instructor 2's and Instructor 3's sections reported using iSTART in other courses, only 50% of the learners in Instructor 1's sections reported engaging in this type of independent practice. Crosstab results for these findings are presented in Table 31.

Table 30

Learners' Use of iSTART in Courses at Second Check-In by Campus

Course Instructor		Used iSTART in Courses – Check-in 2		Total
		Not Used	Strategies Used	
Campus 1	Count	24_a	75_b	99
	% within Campus	24.2%	75.8%	100.0%
	% within Used iSTART in Courses (column)	41.4%	64.7%	56.9%
	% of Total Count (N = 174)	13.8%	43.1%	31.2%
Campus 2	Count	34_a	41_b	55
	% within Campus	45.3%	54.7%	100.0%
	% within Used iSTART in Courses (column)	58.6%	35.3%	43.1%
	% of Total Count (N = 174)	19.5%	23.6%	35.7%
Total	Count	58	116	174
	% within Campus	33.3%	66.7%	100.0%

Note. Each subscript letter denotes a subset of Used iSTART in Courses at second check-in categories whose column proportions do not differ significantly from each other at the .05 level.

Table 31

Learners' Use of iSTART in Courses at Second Check-In by Instructor

Course Instructor		Used iSTART in Courses		Total
		Not Used	Strategies Used	
Instructor1	Count	28_a	28_b	56
	% within Instructor	50.0%	50.0%	100.0%
	% within Used iSTART in Courses (column)	48.3%	24.1%	31.2%
	% of Total Count (*N* = 174)	16.1%	16.1%	31.2%
Instructor2	Count	16_a	45_a	61
	% within Instructor	26.2%	73.8%	100.0%
	% within Used iSTART in Courses (column)	27.6%	38.8%	35.1%
	% of Total Count (*N* = 174)	9.2%	25.9%	35.1%
Instructor3	Count	14_a	43_a	55
	% within Instructor	24.6%	75.4%	100.0%
	% within Used iSTART in Courses (column)	24.1%	37.1%	35.7%
	% of Total Count (*N* = 174)	8.0%	24.7%	35.7%
Total	Count	58	116	174
	% within Instructor	45.5%	54.5%	100.0%

Note. Each subscript letter denotes a subset of Used iSTART in Courses - T1 categories whose column proportions do not differ significantly from each other at the .05 level.

The frequency of learners' strategy use at the second check-in was tallied for each individual strategy in all courses. All strategy use scores across all courses were then combined to generate a total iSTART strategy-use-in-courses score. The independent samples *t*-test was used to compare the means of learners' total use of iSTART reading strategies across their courses by treatment condition and by campus site. On average, learners in the control group reported using significantly more iSTART strategies across all their courses at the second check-in ($M = 5.73$, $SE = 0.55$) than learners in the growth-mindset treatment group ($M = 4.07$, $SE = 0.44$, $t(144) = 2.308$, $p = .02$, 95% BCa [0.238, 3.077], $d = .39$).

On average, there was no significant difference in the number of iSTART strategies used in all courses by learners at Campus 1 ($M = 5.33$, $SE = 0.48$) compared to Campus 2 ($M = 4.36$, $SE = 0.55$) at the second check-in ($t(144) = 1.309$, $p = .19$).

A one-way ANOVA with planned contrasts was used to test whether learners' instructors affected their use of iSTART strategies across other courses. There was no significant effect of instructors on learners' use of iSTART strategies across one or more of their courses (F (2, 143) = 2.406, $p = .09$). Results also showed, however, that there was a marginally significant linear trend regarding instructors' effect on learners' use of iSTART strategies across other courses (F (1, 143) = 3.903, $p = .05$).

A closer examination of learners' strategy use in other courses at the second check-in was conducted by treating all 0 strategy use scores as missing. Another one-way ANOVA with planned contrasts was conducted to test the effect of the instructors on learners' reports of iSTART strategy use in other courses. The first planned contrast tested Instructor 2 against Instructors 1 and 3. The second planned contrast tested Instructor 1 against Instructor 3. When learners reporting no use of iSTART strategies in other courses were excluded from the analyses, there was a significant effect of instructor on learners' use of iSTART strategies in other courses (F (2, 113) = 3.271, $p = .04$). There was also a marginally significant weighted linear trend (F (1, 113) = 3.820, $p =$

.053), indicating that learners' iSTART strategy use in other courses may have been proportionally affected by their first-year course instructors. The first planned contrast showed that for learners who reported using the strategies, having Instructor 2 versus Instructor 1 or 3 significantly affected learners' strategy use in other courses ($t(113) = -10.036$, $p < .001$). The second planned contrast showed that for learners reporting use of the iSTART strategies, having either Instructor 1 or Instructor 3 had no significant effect on the number of strategies they used in other courses ($t(113) = 0{,}479$, $p = .63$). Figure 1 depicts the mean scores for learners' iSTART strategy use in other courses (learners reporting no strategy use were excluded from the analyses), and Table 32 provides descriptive data.

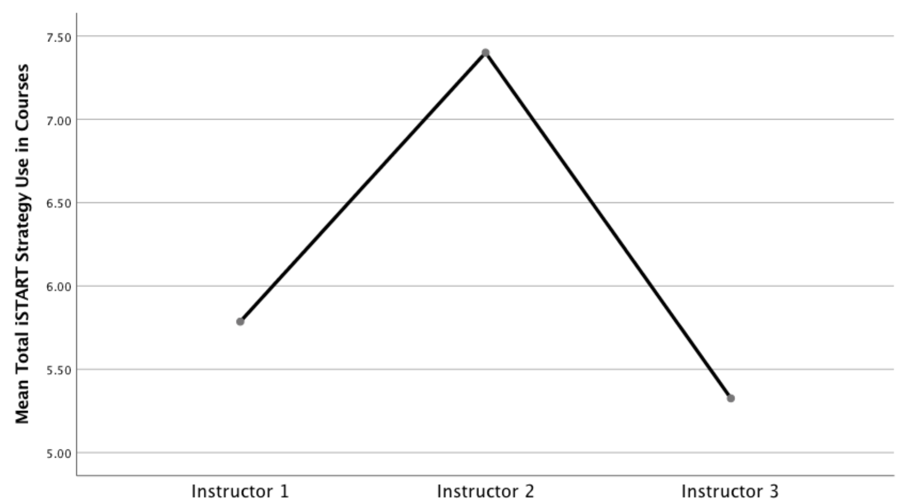

Figure 1. Mean iSTART strategy use in other courses by first-year course instructor.

Table 32

Descriptive Statistics for iSTART Strategy in Course – Second Check-In

Instructor	*N*	*M*	Std. Dev.	Std. Error	Min	Max
Instructor 1	28	5.786	3.745	0.708	1	15
Instructor 2	45	7.400	4.741	0.707	1	25
Instructor 3	43	5.326	3.084	0.470	1	13
Total	116	6.241	4.032	0.374	1	25

Note. Learners reporting no strategy use were excluded from the analyses.

Inferential Testing

Analysis Plan for the First Two Research Questions

Mediation analyses were conducted to test the first two research questions. The purpose of mediation analysis is to examine whether a third variable, the mediator, comes between the independent and dependent variable. In other words, the independent variable (X) leads to the mediator (M), which in turn leads to the dependent variable (Y). Figure 2 depicts a visual representation of this model, whereby mediation is represented through paths *a* and *b*. In theory, the direct path between X and Y (*c*-path) should get smaller once M is included (c'-path). The difference between the two *c*-paths is equal to the product of the *a*-path and *b*-path only when the independent and mediating variables are continuous (Preacher & Hayes, 2008). If the indirect effect ($a*b$) is significant, then mediation is said to have occurred.

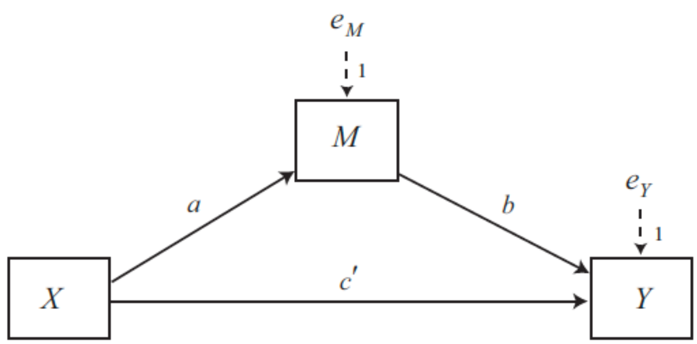

Figure 2. Statistical diagram of mediation (Hayes, 2018). The product of coefficients for paths *a* and *b* = indirect effect of X on Y. Path *c'* = direct effect of X on Y.

There are three common ways to test the indirect effect (*a**b*). One way is to conduct the joint significance test (Baron & Kenny, 1986). In this method, if the *a*-path and *b*-path are both significant, then *a**b* is considered significant. The joint significant test is considered a liberal test and has high Type I error. The second method is the Sobel test (Sobel, 1982). The indirect effect is estimated and the significance is tested using the Sobel test. This method is considered conservative and has high Type II error. Moreover, the Sobel test assumes normal sampling distribution, but the sampling distribution of *a**b* is non-normal, except for with very large samples. The third method is bootstrapping, which is a computer-intensive analytical technique that can be applied to non-normal data (Preacher & Hayes, 2008).

The mediated effect in this study was computed utilizing the product of coefficients to estimate the direct and indirect effects (MacKinnon et al., 2007). Two regression equations were used to compute the effect of the antecedent variables on (1) Y, the dependent variable, and (2) M, the mediator.

1. $Y = i_Y + c' X + bM + e_Y$
2. $M = i_M + aX + e_M$

In the equations above,

- i_Y and i_M are the intercepts (i.e., regression constants);
- c' is the regression coefficient for the relationship between X and Y, controlling for M;
- b is the regression coefficient for the relationship between M and X; and
- e_Y and e_M are errors in the estimate, for the dependent and mediator variables, respectively.

In the first equation, the c' coefficient, which is the direct effect of X on Y, specifies that when M is held constant or is equal for two cases, every difference in 1 unit of X will produce c' units of change in Y. Similarly, the b coefficient specifies that every 1 unit change in M will produce b units of change in Y. In the second equation, the a coefficient specifies that every 1 unit change in X will produce a units of change in M. The indirect effect is computed by the product of a and b and informs us that every 1 unit change in X will produce ab units of change in Y (MacKinnon et al., 2007). A negative indirect effect is determined if one coefficient is positive and the other negative. A positive indirect effect is determined if both *a* and *b* coefficients are positive or negative (Hayes, 2018). Given the hypotheses for this research, double negative indirect effects were not anticipated; consequently, their presence would signify theoretical deviations. Partially standardized indirect effect of [unit change in] X on [standard deviation unit change of] Y is presented to represent the effect size for significant mediation effects (Preacher & Kelley, 2011).

Three mediation models are presented for each hypothesis of research questions 1 and 2 to test the effect of controlling for covariates. For hypotheses 1 through 5 of research question 1, the following covariates were included: (1) treatment condition; (2) treatment condition, reading comprehension strategy use (Time 1), and prior knowledge; and (3) treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race and ethnicity.

For hypotheses 1 through 5 of research question 2, the following covariates were included: (1) treatment condition; (2) treatment condition, reading comprehension strategy use (Time 1), and prior knowledge; and (3) treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race and ethnicity. For hypotheses 6 through 10 of the second research question, the following covariates were included: (1) treatment condition; (2) treatment condition, reading comprehension strategy use (Time 1), and reading skill (Time1); and (3) treatment condition, reading comprehension strategy use (Time 1), reading skill (Time 1), instructor, gender, and race and ethnicity.

Treatment condition was included in the mediation models as a covariate to control for the effects of the experiment. Reading comprehension strategy use, prior knowledge, and reading skill (Time 1) were included, respectively, based upon the literature presented for this research. Instructor, gender, and race and ethnicity were included because these individual differences have been found to impact learning and achievement (Ballantine, 1993; Sidanius, Pratto, van Laar, & Levin, 2004; Wiggan, Scott, Watson, & Reynolds, 2014).

Dummy variables were computed for the multi-categorical variables that contained more than two values in order to distinguish them from quantitative variables. Two dummy variables (g-1) were computed for instructor and gender, respectively, and four dummy variables (g-1) were computed for race and ethnicity.

A conditional process analysis macro called PROCESS Procedure for SPSS Release 2.16.3 (Hayes, 2016) was added to the SPSS statistical package; it is used to estimate direct and indirect effects in models with mediation and moderation. In order to improve the power of the tests to correctly reject false null hypotheses, computer intensive bootstrap resampling through the PROCESS Procedure was used to generate an empirical representation of the sampling distribution to construct confidence intervals (Hayes, 2017). Model 4 of the PROCESS Procedure was used for all mediation analyses. Model 4 tests for mediation with one dependent variable, one mediating variable, and one outcome variable.

The number of bootstrap samples for bias-corrected bootstrap confidence intervals is 5,000 based on Andrews and Buchinsky's (2002) three-step procedure. In step

1, a preliminary number of bootstrap repetitions (B) was determined. The authors suggest that for $p = .05$ and 95% probability, the percentage deviation of the upper and lower confidence intervals should not exceed 10% each (i.e., 20% overall); the minimum number of bootstraps (B) = 1,032; the maximum B = 27,109; and the median B = 6,962. The PROCESS macro offers the following options for varying the number of bootstrap repetitions: B = 2,000; B = 5,000; B = 10,000; B = 20,000; and B = 50,000.

In step 2, a mediation model was run to test whether reading comprehension strategy use (Time 2) mediated the relationship between reading efficacy beliefs (Time 1) and total reading comprehension score (Time 2), when controlling for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race and ethnicity. This simulation was chosen because it had the smallest sample size (N = 102) for the present mediation analyses. Results are presented in Table 33.

Table 33

Bootstrap Simulation Results

B	Bootstrap Results		Bias-corrected CI	
	Effect	SE	Lower	Upper
2,000	0.052	0.176	-0.290	0.413
5,000	0.052	0.179	-0.296	0.416
10,000	0.052	0.174	-0.272	0.418
20,000	0.052	0.177	-0.291	0.412
50,000	0.052	0.176	-0.293	0.414

Note. B = bootstrap repetitions.

In step 3, the exact number of bootstraps for the minimum and maximum repetitions in accordance with Andrews and Buchinsky (2002) could not be simulated with the PROCESS macro. However, the full range of the minimum and maximum values are included in the present simulation. Given that increasing the number of bootstraps from 2,000 to 50,000 did not change the results of the simulation, 10,000 iterations was sufficient for mediation analyses with the present data and well above the 1.000 to 2,000 suggested by other practitioners (Carpenter & Bithell, 2000; Field, 2015).

Research Question 1

The first research question was as follows: Do motivational beliefs mediate the relationship between implicit theories of intelligence and reading comprehension strategy use?

- Null Hypothesis: Motivational beliefs (mediator) do not mediate the relationship between implicit theories of intelligence (independent variable) and reading comprehension strategy use (dependent variable).

- Alternate Hypothesis: Motivational beliefs (mediator) do mediate the relationship between implicit theories of intelligence (independent variable) and reading comprehension strategy use (dependent variable).

Five specific hypotheses were tested to answer the first research question.

1. Mastery-approach goals (Time 1) mediate the positive relationship between incremental intelligence beliefs (Time 1) and reading comprehension strategy use (Time 2).

2. Mastery-avoidance goals (Time 1) mediate the positive relationship between incremental intelligence beliefs (Time 1) and reading comprehension strategy use (Time 2).

3. Performance-approach goals (Time 1) mediate the negative relationship between entity beliefs about intelligence (Time 1) and reading comprehension strategy use (Time 2).

4. Performance-avoidance goals (Time 1) mediate the negative relationship between entity beliefs about intelligence (Time 1) and reading comprehension strategy use (Time 2).

5. Reading efficacy beliefs (Time 1) mediate the positive relationship between incremental beliefs about intelligence (Time 1) and reading comprehension strategy use (Time 2).

A simple mediation analysis, which included one independent variable, one mediator, and one outcome variable, was conducted to test each of the five hypotheses for the first research question. Each hypothesis was examined through three models. Model 1 controlled for treatment condition; Model 2 controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge; and Model 3 controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity. A table of results (see Tables 34 – 38), followed by a brief summary of the findings, is presented for each hypothesis.

Table 34

Results of Mediation Analysis of Hypothesis 1 of RQ1: From Time 1 Incremental Beliefs (IV) to Time 1 Mastery-Approach Goals (M) to Time 2 RC Strategy Use (DV)

	Model 1 (n = 116)				Model 2 (n = 113)				Model 3 (n = 113)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	0.358	0.110	.001	.09	0.326	0.110	.003	.12	0.339	0.113	.004	.27
b_1: M→DV	-1.621	0.851	.06	.04	-0.912	0.814	.27	.22	-0.631	0.861	.47	.33
Total Effect	0.988	1.002	.33	.01	0.650	0.928	.49	.21	1.500	0.973	.13	.33
Direct Effect	1.568	1.036	.13		0.948	0.964	.33		1.714	1.018	.10	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.580	0.390	-1.621	-0.026	-0.297	0.316	-1.163	0.153	-0.214	0.327	-1.070	0.276

Note. M = mediator variable; IV = independent variable; DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model; b_1 = b-path in mediation model.

In the first model, which controlled for treatment condition, the null hypothesis was rejected. There was a significant negative indirect effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) through mastery-approach goals (Time 1) when the treatment condition was held constant (b = -0.580, BCa CI [-1.621, -0.026]). This represented a relatively small effect (ab_{ps} = -0.078); specifically, two learners in the same treatment condition who differed by one unit on the incremental beliefs scale (Time 1) were estimated to differ by 0.078 standard deviations in reading comprehension strategy use (Time 2) as a result of the effect of incremental beliefs (Time 1) on mastery-approach goals (Time 1), which then affected reading comprehension strategy use (Time 2).

In the second model of the first hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) through mastery-approach goals (Time 1) (b = -0.297, BCa CI [-1.163, 0.153]).

In the third model of the first hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) through mastery-approach goals (Time 1) (b = -0.214, BCa CI [-1.070, 0.276]).

Table 35

Results of Mediation Analysis of Hypothesis 2 of RQ1: From Time 1 Incremental Beliefs (IV) to Time 1 Mastery-Avoidance Goals (M) to Time 2 RC Strategy Use (DV)

	Model 1 (n = 117)				Model 2 (n = 114)				Model 3 (n = 114)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	0.103	0.167	.54	.004	0.107	0.169	.53	.02	0.111	0.186	.55	.08
b_1: M→DV	-0.544	0.561	.33	.01	-0.235	0.527	.66	.21	-0.143	0.519	.78	.34
Total Effect	0.785	1.002	.44	.01	0.507	0.924	.59	.21	1.423	0.963	.14	.34
Direct Effect	0.841	1.003	.40		0.532	0.929	.57		1.439	0.969	.14	

		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.056	0.143	-0.569	0.108	-0.025	0.107	-0.411	0.100	-0.016	0.124	-0.412	0.155

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the second hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) through mastery-avoidance goals (Time 1) when the treatment condition was held constant (b = -0.056, BCa CI [-0.569, 0.108]).

In the second model of the second hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) through mastery-avoidance goals (Time 1) (b = -0.025, BCa CI [-0.411, 0.100]).

In the third model of the second hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) through mastery-avoidance goals (Time 1) (b = -0.016, BCa CI [-0.412, 0.155]).

Table 36

Results of Mediation Analysis of Hypothesis 3 of RQ1: From Time 1 Entity Beliefs (IV) to Time 1 Performance-Approach Goals (M) to Time 2 RC Strategy Use (DV)

	Model 1 (n = 117)				Model 2 (n = 114)				Model 3 (n = 114)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	0.030	0.100	.77	.004	0.059	0.104	.57	.01	0.095	0.109	.39	.14
b_1: M→DV	-0.631	0.813	.44	.01	-0.622	0.749	.41	.20	-0.107	0.761	.89	.34
Total Effect	-0.275	0.864	.75	.001	0.085	0.808	.92	.19	-0.756	0.828	.36	.34
Direct Effect	-0.257	0.866	.77		0.121	0.810	.88		-0.746	0.835	.37	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.019	0.106	-0.371	0.117	-0.036	0.104	-0.412	0.078	-0.010	0.113	-0.338	0.169

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = *a*-path in mediation model. b_1 = *b*-path in mediation model.

In the first model of the third hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of entity beliefs (Time 1) on reading comprehension strategy use (Time 2) through performance-approach goals (Time 1) when the treatment condition was held constant (b = -0.019, BCa CI [-0.371, 0.117]).

In the second model of the third hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of entity beliefs (Time 1) on reading comprehension strategy use (Time 2) through performance-approach goals (Time 1) (b = -0.036, BCa CI [-0.412, 0.078]).

In the third model of the third hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of entity beliefs (Time 1) on reading comprehension strategy use (Time 2) through performance-approach goals (Time 1) (b = -0.010, BCa CI [-0.338, 0.169]).

Table 37

Results of Mediation Analysis of Hypothesis 4 of RQ1: From Time 1 Entity Beliefs (IV) to Time 1 Performance-Avoidance Goals (M) to Time 2 RC Strategy Use (DV)

	Model 1 (n = 118)				Model 2 (n = 115)**				Model 3 (n = 115)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	0.035	0.119	.77	.004	0.052	0.124	.68	.01	0.099	0.129	.45	.14
b_1: M→DV	-0.777	0.677	.25	.01	-0.770	0.616	.21	.21	-0.635	0.628	.31	.35
Total Effect	-0.374	0.861	.67	.002	0.053	0.800	.95	.20	-0.822	0.818	.32	.34
Direct Effect	-0.346	0.860	.69		0.093	0.799	.91		-0.760	0.820	.36	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.027	0.132	-0.450	0.151	-0.040	0.120	-0.418	0.120	-0.063	0.129	-0.501	0.088

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model. **at 50,000 bootstraps.

In the first model of the fourth hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of entity beliefs (Time 1) on reading comprehension strategy use (Time 2) through performance-avoidance goals (Time 1) when the treatment condition was held constant (b = -0.027, BCa CI [-0.450, 0.151]).

In the second model of the fourth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of entity beliefs (Time 1) on reading comprehension strategy use (Time 2) through performance-avoidance goals (Time 1) (b = -0.040, BCa CI [-0.418, 0.120]).

In the third model of the fourth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of entity beliefs (Time 1) on reading comprehension strategy use (Time 2) through performance-avoidance goals (Time 1) (b = -0.063, BCa CI [-0.501, 0.088]).

Table 38

Results of Mediation Analysis of Hypothesis 5 of RQ1: From Time 1 Incremental Beliefs (IV) to Time 1 Reading Efficacy Beliefs (M) to Time 2 RC Strategy Use (DV)

	Model 1 (n = 108)				Model 2 (n= 105)				Model 3 (n = 105)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	0.041	0.190	.83	.01	0.069	0.188	.71	.13	0.122	0.200	.54	.23
b_1: M→DV	0.683	0.549	.22	.02	0.212	0.532	.69	.21	0.183	0.544	.74	.34
Total Effect	0.276	1.072	.80	.001	0.252	0.996	.80	.21	1.316	1.037	.21	.33
Direct Effect	0.248	1.069	.82		0.237	1.001	.81		1.294	1.044	.22	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	0.028	0.166	-0.229	0.491	0.015	0.108	-0.107	0.387	0.022	0.144	-0.147	0.488

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 Strategy Use, and Prior Knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the fifth hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) through reading efficacy beliefs (Time 1) when the treatment condition was held constant (b = 0.028, BCa CI [-0.229, 0.491]).

In the second model of the fifth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) through reading efficacy beliefs (Time 1) (b = 0.015, BCa CI [-0.107, 0.387]).

In the third model of the fifth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) through reading efficacy beliefs (Time 1) (b = 0.022, BCa CI [-0.147, 0.488]).

Summary of mediation analysis for first research question. With the exception of the first model for the first hypothesis, the null hypotheses were retained. Model 1 of the first hypothesis tested whether incremental beliefs at Time 1 affected reading comprehension strategy use at Time 2 via mastery-approach goals (see Table 34). Regressing mastery-approach goals (Time 1) on incremental beliefs at Time 1 and controlling for treatment condition showed that they were related (a_1 = 0.358, SE = 0.110, p < .01, BCa CI [0.1411, 0.5748]). Regressing reading comprehension strategy use (Time

2) on mastery-approach goals (Time 1) and controlling for treatment condition showed that maintaining mastery-approach goals had a deleterious effect on reading comprehension strategy use, which was just short of significance (b = -1.621, SE = 0.851, p = .06, BCa CI [-3.3074, 0.0655]).

Mediation analyses showed that mastery-approach goals (Time 1) significantly mediated the effects of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) (b = -0.580, BCa CI [-1.621, -0.026]). The partially standardized indirect effect (ab_{ps} = -0.078) indicates that a learner who is one unit higher in incremental beliefs at Time 1 than his or her peers is estimated to be 0.078 of a standard deviation lower in reading comprehension strategy use at Time 2 than his or her peers as a result of the effect of mastery-approach goals at Time 1.

There is evidence of a suppression effect in Model 1. A suppression effect occurs when inclusion of a mediating variable increases the magnitude of the relationship between an independent variable and a dependent variable (Cheung & Lau, 2008). For typical mediation models, the magnitude of the isolated relationship between the independent variable and the dependent variable (total effect) is expected to decrease with the inclusion of a mediator variable (direct effect), since the mediator is expected to absorb some of the independent variable's explanatory power (MacKinnon, Krull, & Lockwood, 2000). In Model 1 of hypothesis 1, there was a non-significant total effect of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) (b = 0.988, p = .33). When the relationship between the mediator, mastery-approach goals (Time 1), and reading comprehension strategy use (Time 2) were accounted for (b = -1.621, p =

.06), the magnitude of the relationship between incremental beliefs (Time 1) on reading comprehension strategy use (Time 2) intensified (direct effect) (b = 1.568, p = .13). This indicates that the mediating variable, mastery-approach goals (Time 1), had a suppression effect with regard to the relationship of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2). The differing signs of the coefficients for the direct and indirect effects in Model 1 also support evidence of a suppression effect (MacKinnon et al., 2000). Although incremental beliefs (Time 1) had a positive (albeit not a significant) effect on reading comprehension strategy use (Time 2), the mediational path through mastery-approach goals led to lower use of reading comprehension strategies (Time 2). Figure 3 depicts the results of these analyses.

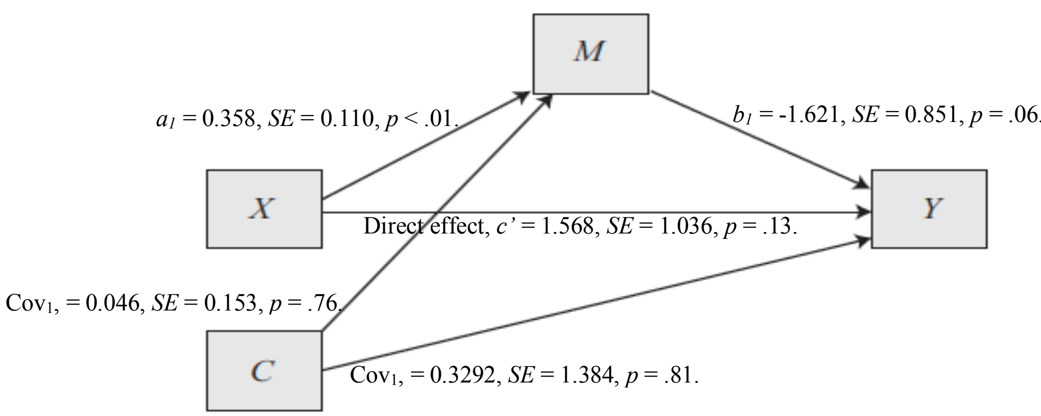

Figure 3. Model of results for the first hypothesis of research question one. T1 incremental beliefs as a predictor (X) of T2 reading comprehension strategy use (Y), mediated by T1 mastery-approach goals (M), controlling for treatment condition (C).

Research Question 2

The second research question was as follows: Does reading comprehension strategy use mediate the relationship between motivational beliefs and achievement outcomes?

- Null Hypothesis: Reading comprehension strategy use (mediator) does not significantly mediate the relationship between motivational beliefs (independent variable) and achievement outcomes (dependent variable).

- Alternate Hypothesis: Reading comprehension strategy use (mediator) does significantly mediate the relationship between motivational beliefs (independent variable) and achievement outcomes (dependent variable).

Ten specific hypotheses were tested to answer the second research question. The first five hypotheses were as follows:

1. Reading comprehension strategy use (Time 2) mediates the positive relationship between mastery-approach goals (Time 1) and total reading comprehension score (Time 2).

2. Reading comprehension strategy use (Time 2) mediates the negative relationship between mastery-avoidance goals (Time 1) and total reading comprehension score (Time 2).

3. Reading comprehension strategy use (Time 2) mediates the positive relationship between performance-approach goals (Time 1) and total reading comprehension score (Time 2).

4. Reading comprehension strategy use (Time 2) mediates the negative relationship between performance-avoidance goals (Time 1) and total reading comprehension score (Time 2).

5. Reading comprehension strategy use (Time 2) mediates the positive relationship between reading efficacy beliefs (Time 1) and total reading comprehension score (Time 2).

A simple mediation analysis, which included one independent variable, one mediator, and one outcome variable, was conducted to test each of the first five hypotheses of the second research question. Each hypothesis was examined three times. Model 1 controlled for treatment condition; Model 2 controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge; and Model 3 controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race and ethnicity. A table of results (see Tables 39 – 43), followed by a brief summary of the findings, is presented for each hypothesis.

Table 39

Results of Mediation Analysis of Hypothesis 1 of RQ2: From Time 1 Mastery-Approach Goals (IV) to Time 2 RC Strategy Use (M) to Time 2 Total RC Score (DV)

	Model 1 (n = 115)				Model 2 (n = 112)				Model 3 (n = 112)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	-0.633	0.781	.42	.01	-0.276	0.747	.71	.18	0.289	0.781	.71	.30
b_1: M→DV	0.356	0.048	<.001	.34	0.294	0.051	<.001	.41	0.336	0.056	<.001	.45
Total Effect	-0.300	0.480	.53	.01	0.150	0.448	.74	.23	0.117	0.503	.82	.24
Direct Effect	-0.075	0.395	.85		0.231	0.392	.56		0.203	0.432	.96	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.225	0.283	-0.797	0.310	-0.081	0.219	-0.526	0.340	0.097	0.270	-0.413	0.657

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the first hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of mastery-approach goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.225, BCa CI [-0.797, 0.310]).

In the second model of the first hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of mastery-approach goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.081, BCa CI [-0.526, 0.340]).

In the third model of the first hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of mastery-approach goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = 0.097, BCa CI [-0.413, 0.657]).

Table 40

Results of Mediation Analysis of Hypothesis 2 of RQ2: From Time 1 Mastery-Avoidance Goals (IV) to Time 2 RC Strategy Use (M) to Time 2 Total RC Score (DV)

	Model 1 (n = 116)				Model 2 (n = 113)				Model 3 (n = 113)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	-0.488	0.550	.38	.01	-0.304	0.523	.56	.18	-0.150	0.517	.77	.31
b_1: M→DV	0.359	0.047	<.001	.35	0.294	0.05	<.001	.42	0.337	0.055	<.001	.45
Total Effect	-0.039	0.337	.91	.01	0.167	0.311	.59	.24	0.121	0.333	.72	.25
Direct Effect	0.136	0.275	.62		0.256	0.272	.35		0.171	0.285	.55	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.175	0.199	-0.559	0.226	-0.089	0.150	-0.381	0.216	-0.051	0.189	-0.437	0.315

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the second hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of mastery-avoidance goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.175, BCa CI [-0.559, 0.226]).

In the second model of the second hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of mastery-avoidance goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.089, BCa CI [-0.381, 0.216]).

In the third model of the second hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of mastery-avoidance goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.051, BCa CI [-0.437, 0.315]).

Table 41

Results of Mediation Analysis of Hypothesis 3 of RQ2: From Time 1 Performance-Approach Goals (IV) to Time 2 RC Strategy Use (M) to Time 2 Total RC Score (DV)

	Model 1 (n = 113)				Model 2 (n = 110)				Model 3 (n = 110)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	-0.122	0.819	.88	.00	-0.073	0.763	.92	.17	0.384	0.77	.62	.31
b_1: M→DV	0.356	0.048	<.001	.35	0.295	0.051	<.001	.41	0.343	0.046	<.001	.45
Total Effect	-0.344	0.500	.49	.01	-0.174	0.456	.70	.22	-0.162	0.498	.75	.24
Direct Effect	-0.300	0.409	.46		-0.152	0.398	.70		-0.294	0.426	.49	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.043	0.298	-0.641	0.531	-0.216	0.226	-0.474	0.423	0.132	0.285	-0.411	0.718

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the third hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of performance-approach goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.043, BCa CI [-0.641, 0.531]).

In the second model of the third hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of performance-approach goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.022, BCa CI [-0.474, 0.423]).

In the third model of the third hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of performance-approach goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.132, BCa CI [-0.411, 0.718]).

Table 42

Results of Mediation Analysis of Hypothesis 4 of RQ2: From Time 1 Performance-Avoidance Goals (IV) to Time 2 RC Strategy Use (M) to Time 2 Total RC Score (DV)

	Model 1 (n = 114)				Model 2 (n = 111)				Model 3 (n = 111)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	-0.493	0.682	.47	.00	-0.515	0.629	.42	.19	-0.419	0.644	.52	.31
b_1: M→DV	0.358	0.047	<.001	.35	0.292	0.051	<.001	.42	0.339	0.056	<.001	.46
Total Effect	-0.450	0.417	.28	.02	-0.391	0.375	.30	.24	-0.404	0.415	.33	.25
Direct Effect	-0.274	0.341	.42		-0.241	0.329	.47		-0.262	0.356	.46	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.176	0.257	-0.708	0.303	-0.151	0.176	0.516	0.181	-0.142	0.226	-0.568	0.349

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the fourth hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of performance-avoidance goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.176, BCa CI [-0.708, 0.303]).

In the second model of the fourth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of performance-avoidance goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.151, BCa CI [-0.516, 0.181]).

In the third model of the fourth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of performance-avoidance goals (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = -0.142, BCa CI [-0.568, 0.349]).

Table 43

Results of Mediation Analysis of Hypothesis 5 of RQ2: From Time 1 Reading Efficacy Beliefs (IV) to Time 2 RC Strategy Use (M) to Time 2 Total RC Score (DV)

	Model 1 (n = 105)				Model 2 (n = 102)				Model 3 (n = 102)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	0.498	0.547	.37	.01	0.148	0.535	.78	.18	0.155	0.548	.78	.30
b_1: M→DV	0.359	0.046	<.001	.41	0.301	0.050	<.001	.47	0.333	0.054	<.001	.51
Total Effect	0.749	0.322	.02	.06	0.644	0.307	.04	.27	0.608	0.332	.07	.30
Direct Effect	0.570	0.257	.03		0.599	0.263	.02		0.557	0.279	.05	

		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	0.179	0.170	-0.140	0.542	0.045	0.156	-0.267	0.354	0.052	0.177	-0.293	0.424

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the fifth hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of reading efficacy (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = 0.179, BCa CI [-0.140, 0.542]).

In the second model of the fifth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of reading efficacy (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = 0.045, BCa CI [-0.267, 0.354]).

In the third model of the fifth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of reading efficacy (Time 1) on total reading comprehension score (Time 2) through reading comprehension strategy use (Time 2) (b = 0.052, BCa CI [-0.293, 0.424]).

Summary of mediation analysis for hypotheses 1 through 5 of the second research question. The null hypotheses were retained for all models. There were no significant indirect effects. In addition, the *a*-path for each of the five hypotheses, where reading comprehension strategy use at Time 2 is regressed on the four Time 1 achievement goals and reading efficacy beliefs, was not significant. Conversely, the *b*-path, where Time 2 total reading comprehension scores were regressed on Time 2 reading comprehension strategy use was significant for each of the three models of hypotheses one through five. Finally, for hypothesis 5, where the mediational path from Time 1 reading efficacy to Time 2 reading comprehension strategy use to Time 2 total reading comprehension scores was examined, Model 1 and Model 2 had significant total and direct effects, and Model 3 had marginally significant total and direct effects.

Research Question 2

The second research question was as follows: Does reading comprehension strategy use mediate the relationship between motivational beliefs and achievement outcomes?

- Null Hypothesis: Reading comprehension strategy use (mediator) does not significantly mediate the relationship between motivational beliefs (independent variable) and achievement outcomes (dependent variable).

- Alternate Hypothesis: Reading comprehension strategy use (mediator) does significantly mediate the relationship between motivational beliefs (independent variable) and achievement outcomes (dependent variable).

Hypotheses 6 through 10 were as follows:

6. Reading comprehension strategy use (Time 2) mediates the positive relationship between mastery-approach goals (Time 1) and reading skill (Time 2).

7. Reading comprehension strategy use (Time 2) mediates the negative relationship between mastery-avoidance goals (Time 1) and reading skill (Time 2).

8. Reading comprehension strategy use (Time 2) mediates the positive relationship between performance-approach goals (Time 1) and reading skill (Time 2).

9. Reading comprehension strategy use (Time 2) mediates the negative relationship between performance-avoidance goals (Time 1) and reading skill (Time 2).

10. Reading comprehension strategy use (Time 2) mediates the positive relationship between reading efficacy beliefs (Time 1) and reading skill (Time 2).

A simple mediation analysis, which included one independent variable, one mediator, and one outcome variable, was conducted to test each of the remaining five hypotheses for the second research question. Each hypothesis was examined through three models. Model 1 controlled for treatment condition; Model 2 controlled for treatment condition, reading comprehension strategy use (Time 1), and reading skill (Time 1); and Model 3 controlled for treatment condition, reading comprehension strategy use (Time 1), reading skill (Time 1), instructor, gender, and race and ethnicity. A table of results (see Tables 44 – 48), followed by a brief summary of the findings, is presented for each hypothesis.

Table 44

Results of Mediation Analysis of Hypothesis 6 of RQ2: From Time 1 Mastery-Approach Goals (IV) to Time 2 RC Strategy Use (M) to Time 2 Reading Skill (DV)

	Model 1 (n = 119)				Model 2 (n = 117)				Model 3 (n = 117)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	-1.002	0.778	.20	.01	-1.058	0.792	.18	.05	-0.056	0.821	.95	.23
b_1: M→DV	0.063	0.029	.03	.05	0.053	0.029	.07	.11	0.0351	0.033	.28	.16
Total Effect	-0.119	0.246	.63	.02	-0.137	0.247	.58	.08	-0.042	0.273	.88	.15
Direct Effect	-0.056	0.244	.82		-0.081	0.246	.74		-0.040	0.273	.88	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.063	0.063	-0.247	0.017	-0.056	0.059	-0.240	0.012	-0.002	0.038	-0.101	0.067

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the sixth hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of mastery-approach goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.063, BCa CI [-0.247, 0.017]).

In the second model of the sixth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of mastery-approach goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.056, BCa CI [-0.240, 0.012]).

In the third model of the sixth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of mastery-approach goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.002, BCa CI [-0.101, 0.067]).

Table 45

Results of Mediation Analysis of Hypothesis 7 of RQ2: From Time 1 Mastery-Avoidance Goals (IV) to Time 2 RC Strategy Use (M) to Time 2 Reading Skill (DV)

	Model 1 (n = 120)				Model 2 (n = 118)				Model 3 (n = 118)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	-0.343	0.563	.54	.00	-0.383	0.565	.50	.04	-0.104	0.540	.85	.24
b_1: M→DV	0.068	0.028	.01	.11	0.060	0.028	.03	.16	0.037	0.031	.24	.22
Total Effect	0.410	0.171	.02	.06	0.420	0.169	.01	.13	0.476	0.173	.01	.21
Direct Effect	0.433	0.168	.01		0.443	0.167	.01		0.480	0.173	.01	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.023	0.044	-0.140	0.046	-0.023	0.038	-0.130	0.031	-0.004	0.029	-0.094	0.036

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the seventh hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of mastery-avoidance goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.023, BCa CI [-0.140, 0.046]).

In the second model of the seventh hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of mastery-avoidance goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.023, BCa CI [-0.130, 0.031]).

In the third model of the seventh hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of mastery-avoidance goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.004, BCa CI [-0.094, 0.036]).

Table 46

Results of Mediation Analysis of Hypothesis 8 of RQ2: From Time 1 Performance-Approach Goals (IV) to Time 2 RC Strategy Use (M) to Time 2 Reading Skill (DV)

	Model 1 (n = 117)				Model 2 (n = 115)				Model 3 (n = 115)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	-0.554	0.787	.48	.00	-0.648	0.798	.42	.03	0.102	0.790	.90	.24
b_1: M→DV	0.064	0.029	.03	.05	0.057	0.029	.06	.11	0.036	0.033	.28	.16
Total Effect	0.059	0.248	.81	.01	0.092	0.247	.71	.08	0.207	0.264	.43	.15
Direct Effect	0.095	0.244	.70		0.128	0.245	.60		0.204	0.264	.44	
		BCa 95% CI				BCa 95% CI**				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.035	0.059	-0.198	0.044	-0.037	0.055	-0.205	0.032	0.004	0.041	-0.058	0.118

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model. **at 50,000 bootstraps.

In the first model of the eighth hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of performance-approach goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.035, BCa CI [-0.198, 0.044]).

In the second model of the eighth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of performance-approach goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.037, BCa CI [-0.205, 0.032]).

In the third model of the eighth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of performance-approach goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = 0.004, BCa CI [-0.058, 0.118]).

Table 47

Results of Mediation Analysis of Hypothesis 9 of RQ2: From Time 1 Performance-Avoidance Goals (IV) to Time 2 RC Strategy Use (M) to Time 2 Reading Skill (DV)

	Model 1 (n = 118)				Model 2 (n = 116)				Model 3 (n = 116)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	-0.687	0.663	.30	.01	-0.691	0.668	.30	.04	-0.356	0.669	.60	.24
b_1: M→DV	0.068	0.028	.02	.08	0.060	0.029	.04	.14	0.040	0.032	.22	.21
Total Effect	0.306	0.206	.14	.03	0.357	0.204	.08	.10	0.540	0.217	.01	.20
Direct Effect	0.352	0.203	.09		0.399	0.202	.05		0.554	0.217	.01	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	-0.047	0.057	-0.212	0.028	-0.042	0.052	-0.198	0.022	-0.014	0.038	-0.148	0.031

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the ninth hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of performance-avoidance goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.047, BCa CI [-0.212, 0.028]).

In the second model of the ninth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of performance-avoidance goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.042, BCa CI [-0.198, 0.022]).

In the third model of the ninth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of performance-avoidance goals (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = -0.014, BCa CI [-0.148, 0.031]).

Table 48

Results of Mediation Analysis of Hypothesis 10 of RQ2: From Time 1 Reading Efficacy Beliefs (IV) to Time 2 RC Strategy Use (M) to Time 2 Reading Skill (DV)

	Model 1 (n = 109)				Model 2 (n = 107)				Model 3 (n = 107)			
	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2	Coeff.	SE	p	R^2
a_1: IV→ M	0.806	0.534	.13	.02	0.789	0.554	.16	.07	0.729	0.538	.18	.25
b_1: M→DV	0.050	0.030	.09	.04	0.041	0.030	.18	.09	0.028	0.034	.42	.14
Total Effect	0.169	0.165	.31	.02	0.118	0.171	.49	.07	0.025	0.178	.89	.14
Direct Effect	0.129	0.165	.44		0.085	0.172	.62		0.005	0.180	.98	
		BCa 95% CI				BCa 95% CI				BCa 95% CI		
		SE	LL	UL		SE	LL	UL		SE	LL	UL
Indirect Effect	0.041	0.037	-0.004	0.151	0.033	0.035	-0.010	0.143	0.020	0.035	-0.019	0.139

Note. M = mediator variable. IV = independent variable. DV = dependent variable. Model 1 controls for treatment condition. Model 2 controls for treatment condition, T1 strategy use, and prior knowledge. Model 3 controls for treatment condition, T1 strategy use, prior knowledge, gender, race/ethnicity, and instructor. a_1 = a-path in mediation model. b_1 = b-path in mediation model.

In the first model of the tenth hypothesis, which controlled for treatment condition, the null hypothesis was retained. There was no significant indirect effect of reading efficacy (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = 0.041, BCa CI [-0.004, 0.151]).

In the second model of the tenth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), and prior knowledge, the null hypothesis was retained. There was no significant indirect effect of reading efficacy (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = 0.033, BCa CI [-0.010, 0.143]).

In the third model of the tenth hypothesis, which controlled for treatment condition, reading comprehension strategy use (Time 1), prior knowledge, instructor, gender, and race/ethnicity, the null hypothesis was retained. There was no significant indirect effect of reading efficacy (Time 1) on total reading skill (Time 2) through reading comprehension strategy use (Time 2) (b = 0.020, BCa CI [-0.019, 0.139]).

Summary of mediation analyses for hypotheses 6 through 10 of the second research question. The null hypotheses were retained for all models. Similar to the results for the first five hypotheses of this research question, there were no significant indirect effects. In addition, there were no significant direct effects, total effects, *a*-paths, or *b*-paths, for the three models examined for hypotheses 10, where the mediational path from Time 1 reading efficacy to Time 2 reading comprehension strategy use to Time 2 reading comprehension skill was examined.

The b-path for Model 1 of hypotheses 6 through 9 (i.e., where the achievement goals were included as the independent variable) where reading skill at Time 2 was regressed on reading comprehension strategy use at Time 2 showed that there was a significant relationship (p = .01 to p = .03) between the two variables. The significant relationship between reading comprehension strategy use at Time 2 and reading skill at Time 2 was sustained for Model 2 of hypotheses 7 and n, when mastery-avoidance (p = .03) and performance-avoidance (p = .04) were included as the predictor variables. The strength of the observed significant relationships for the b-path was not as strong as observed b-path relationships in hypotheses 1 through 5, where the dependent variable was total reading comprehension scores. The significant b-paths for hypotheses 6 through 9, where Time 2 reading skill was the dependent variable, had coefficients ranging from b_1 = 0.060 to 0.068 with R^2 = .05 to .16. The significant b-paths for hypotheses 1 through 5, where Time 2 total reading comprehension scores was the dependent variable, had coefficients ranging from b_1 = 0.292 to 0.359 with R^2 = .34 to .51.

Finally, for hypothesis 7, where the mediational path from Time 1 mastery-avoidance to Time 2 reading comprehension strategy use to Time 2 reading comprehension skill was examined, total effect and direct effect were significant in each of the three models. Model 3 of hypothesis 9, where the mediational path from Time 1 performance-avoidance to Time 2 reading comprehension strategy use to Time 2 reading comprehension skill was examined, also had significant total and direct effects.

Analysis Plan for Third Research Question

The third research question was as follows: Does a growth-mindset intervention influence learners' endorsement of intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes?

- Null Hypothesis: H_0: $\mu_1 = \mu_2$
- Alternate Hypothesis: H_0: $\mu_1 \neq \mu_2$

The following multivariate hypotheses were tested to answer this question:

1. Compared to the control group, the growth-mindset intervention group will have stronger T2 incremental beliefs about intelligence.
2. Compared to the control group, the intervention group will have stronger T2 mastery-approach achievement goals.
3. Compared to the control group, the intervention group will have weaker T2 mastery-avoidance achievement goals.
4. Compared to the control group, the intervention group will have weaker T2 performance-approach achievement goals.
5. Compared to the control group, the intervention group will have weaker T2 performance-avoidance achievement goals.
6. Compared to the control group, the intervention group will have greater T2 reading efficacy.
7. Compared to the control group, the intervention group will have greater T2 reading comprehension strategy use scores.
8. Compared to the control group, the intervention group will use more deep-level reading comprehension strategies.
9. Compared to the control group, the intervention group will use more surface-level reading comprehension strategies.

10. Compared to the control group, the intervention group will have stronger reading comprehension at the textbase.

11. Compared to the control group, the intervention group will have stronger reading comprehension at the situation model.

12. Compared to the control group, the intervention group will have greater T2 reading skill scores.

13. Compared to the control group, the intervention group will have better grades.

Multivariate analysis of variance (MANOVA) procedures were conducted to test the third research question. MANOVA is similar to ANOVA in that they are both a part of the general linear modeling class of statistical tests and can be used to determine the effects of an experimental treatment on dependent variables (Huberty & Morris, 1989). ANOVA is typically used to test the differences between group means on one dependent variable, but MANOVA is often used in educational research to test unobserved phenomena based upon two or more dependent variables (Warne, 2014). For example, in this research, the effects of the growth-mindset treatment (i.e., an unobserved phenomenon) is tested by examining group differences on multiple correlated and theoretically bound dependent variables (i.e., T2 intelligence beliefs, T2 motivational beliefs, strategy use, and academic outcomes).

The primary purpose of MANOVA is determined by the nature of the research question and involves simultaneously examining the relationships of independent variables and dependent variables to (1) construct a predictive model, or (2) predict group membership (Huberty, 1994; Stevens, 2002). In either case, MANOVA tests the effect of the independent or grouping variable(s) on multiple correlated dependent variables (Keselman et al., 1998).

MANOVA, rather than a series of ANOVA is recommended to explore research questions that query multivariate effects (Keselman et al., 1998). When the research purpose includes determining multivariate effects, employing MANOVA rather than serial ANOVAs to account for multiple dependent variables reduces the risk of Type I error (Huberty & Olejnik, 2006). According to Warne (2014), conducting a series of two ANOVAs rather than one MANOVA can increase the probability of committing a Type 1 error across the experimental test from $\alpha = .05$ to $\alpha = .0975$.

The following ten assumptions for using MANOVA were examined with respect to the present study's data:

1. Two or more continuous dependent variables (i.e., interval or ratio level)
2. At least one independent categorical variable with two or more independent groups
3. Independence of observations or random sampling
4. No univariate or multivariate outliers. Cook's distance and scatterplots test this assumption.
5. No multicollinearity assessed by the Variance Inflation Factor (VIF) tested for multicollinearity.
6. Multivariate normality. Univariate normality and bivariate scatter plots were used to test this assumption.
7. Linear relationship between each pair of dependent variables (i.e., they were correlated) within each treatment condition. SPSS split file command and visual inspection of a scatterplot matrix were used to test this assumption.
8. Adequate sample size such that the number of cases in the smallest group is equal or greater than six times the number of predictor variables being analyzed.

9. Homogeneity of the variance-covariance matrices was tested with Box's M test of equality covariance.
10. Homogeneity of variances was tested with Levene's test of the equality of error variances.

The first three assumptions of MANOVA relate to the study design and have been met in this research.

First, the assumption of two or more continuous variables was met. Fourteen continuous dependent variables were initially considered for inclusion in the model (i.e., Time 2 measures of incremental, mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, reading efficacy, strategy use, paraphrase strategy, bridging strategy, reading comprehension at textbase, reading comprehension bridging, reading comprehension elaboration, total reading comprehension, and reading skill). In the end, 11 dependent variables were analyzed by MANOVA. Details on the selection process are included below.

Second, the assumption of at least one independent categorical variable with two or more independent groups was met. Treatment condition, a two-level grouping variable, identifying case membership in either the control or growth-mindset treatment condition was the independent variable for these analyses.

Third, the assumption of independence of observations was met because participants were randomly assigned to the treatment condition. In addition, during data collection, learners worked independently on separate computers to complete assignments in iSTART, surveys, and reading comprehension tasks.

The remaining assumptions pertain to the fit of the data to the MANOVA model and were tested in SPSS.

Fourth, the assumption of no univariate or multivariate outliers was met. The handling of univariate outliers was discussed above. The data were also examined to detect multivariate outliers. SPSS Cook's distance, which is available as a part of the regression procedure, was used to determine whether certain scores exerted undue influence on the multivariate mean. Stevens (2002) recommended using Cook's distance because the statistic identifies influential points by taking into consideration the effect of a score being a multivariate outlier (i.e., Mahalanobis distance), as well as its leverage or distance from the multivariate mean. Through this process, maximum data were preserved since only data points that would influence the outcome of the analyses were removed from the dataset. Cook's distance > 1 is considered to be a large influence and a reason for concern (Stevens, 2002).

For these data, Cook's distance ranged from 0.000 to 0.067 (M = 0.010, SD = 0.010). A scatterplot of Cook's distances was created to view the values graphically, using case numbers as the x-axis. One possible multivariate outlier on y was identified by visually examining the scatterplot. For this case, Cook's distance = 0.067. The next closest observation was about three standard deviation points away, with Cook's distance = 0.038. The MANOVA was conducted with the multivariate outlier included because it was within the acceptable range of Cook's distance (<1) and therefore was not expected to exert undue influence on the MANOVA. According to Stevens (2002), "If a point is a significant outlier on y, but its Cook distance is <1, there is no real need to delete the point because it does not have a large effect on the regression analysis" (p. 135).

Fifth, the assumption of no multicollinearity was validated. In addition to visual inspection of the Time 1 and Time 2 correlations matrices, multicollinearity was tested by conducting a VIF analysis through the SPSS regression procedure. All 14 aforementioned Time 2 dependent variables were included in the analysis. Treatment condition was included as the independent variable for both analyses. Output on VIF, an indicator of multicollinearity, and tolerance, an indicator of the redundancy of the explanatory information for each predictor variable, was examined. Although it can be present at lower levels, VIF = 10 or greater is indicative of multicollinearity (Stevens, 2002; Vatcheva et al., 2016). With regard to tolerance (Tol), the lower the value, the higher the level of redundant information in the dependent variable for explaining group-level differences. Results are presented where VIF was equal to or greater than 10.

Multicollinearity was evident among Time 2 strategy use (VIF = 57.383, Tol = .017) and Time 2 paraphrase strategy (VIF = 49.078, Tol = .020), where $r = .98$, $p < 0.001$. Multicollinearity was also evident among total reading comprehension score (VIF = 209.479, Tol = .005). The following measures were also evident: reading comprehension at the textbase (VIF = 91.511, Tol = .011), where $r = .83$, $p < 0.001$; reading comprehension bridging (VIF = 55.409, Tol = .018), where $r = .80$, $p < 0.001$; and reading comprehension elaboration (VIF = 12.145, Tol = .082), where $r = .55$, $p < 0.001$.

Multicollinearity was resolved by employing the use of two MANOVAs. For the original MANOVA (i.e., first MANOVA), specific variables were methodically excluded to reduce redundancy and improve the explanatory power of the multivariate analyses. Specifically, for the first MANOVA, paraphrasing and bridging strategies were excluded and Time 2 strategy use was included. In addition, reading comprehension at the textbase, reading comprehension bridging, and reading comprehension elaboration were excluded so that total reading comprehension scores could be included in the first MANOVA. In the second MANOVA analysis, paraphrase strategy was included and Time 2 strategy use and bridge strategy were excluded. The exclusion of bridge strategy from both analyses was for reasons other than just multicollinearity; they are discussed below. Additionally, reading comprehension at the textbase, reading comprehension bridging, and reading comprehension elaboration were included, while total reading comprehension score was excluded from the second MANOVA. After the separation of the highly correlated variables, both subsequent VIF analyses showed that multicollinearity was successfully attenuated ($VIF < 2.5$) for all predictor variables in both MANOVA models. In addition, tolerance statistics increased, indicating that the levels of redundancy decreased among the predictor variables.

Sixth, the assumption of multivariate normality was validated. Since all variables were previously assessed for univariate normality, multivariate normality was assessed by examining scatterplots for pairs of variables in SPSS. While this process does not provide complete assurance that multivariate normality is achieved, it is commonly accepted research practice because MANOVA is robust against violations of this assumption (Huberty & Olejnik, 2006; Stevens, 2002).

Seventh, data linearity was assessed by constructing a scatter dot matrix using the SPSS legacy dialogue function. SPSS split file procedure was used in order to analyze linearity for data pertaining to each treatment group. The graph chart builder function was used to construct a scatterplot matrix of the 14 dependent variables with a line of best fit. The properties dialogue box was then used to specify the best fit method as Loess to 90% of the data points. Visual inspection of the scatterplots and the Loess fit lines were used to test for approximate linearity. Using this procedure, the general direction of the data in each cell was visually assessed, where a diagonal oval shape is ideal. Given that this was not the case for most of the data, Loess lines were examined to ascertain if they were horizontally flat or curved to form a bowed pattern, which are conditions considered to be non-linear. Results of the test indicated that the relationship between each pair of the 14 dependent variables approximated linearity within the growth-mindset treatment and control conditions.

Eighth, the completeness of the data matrix is problematic as it had a considerable adverse impact on sample size. As discussed above, there was a substantial amount of missing data. Gaps in the data matrix have a profound impact on MANOVA because it reduces the groups' sample sizes and, consequently, the power of MANOVA test statistics (Finch & French, 2013). The variables of greatest concern were the Time 2 strategy use, total reading comprehension, and reading efficacy scores, with missing scores of $N = 52$, $N = 32$, and $N = 20$, respectively.

Even with a data matrix at full complement, the number of dependent variables (P) for this research was relatively large given the small sample size. Keselman et al. (1998) recommend that "the smallest group size should range from $6P$ to $10P$" (p. 361). The smallest group size for this data was $N = 84$, for the growth-mindset intervention group. Consequently, with a data matrix at full complement, the group size for the second MANOVA was just within the recommended lower limits (i.e., where $P = 12$, the recommended smallest group is $N = 72 – 120$). However, the tabulated patterns matrix produced for the SPSS missing data analyses showed that if Time 2 strategy use, total reading comprehension, and Time 2 reading efficacy scores were included in any analyses, the number of complete cases would be reduced to $N = 112$, which represented a loss of approximately one-third of the data.

Since the aforementioned variables were central to this research, three separate MANOVA models were methodically constructed to reduce the number of dependent variables in each model and improve the power of the MANOVA tests. In addition, as discussed above, bridging strategy was excluded from these analyses for reasons other than multicollinearity. Examination of the data matrix showed that if bridging strategy was included in the multivariate analyses, the combined sample size for both groups was severely constrained to $N < 50$. Since paraphrasing was the only strategy included in the model, reading comprehension bridging and reading comprehension elaboration were excluded, as well, which reduced the number of dependent variables for the second MANOVA to a modest level.

Table 49 summarizes the dependent variables for each MANOVA model. The first and second MANOVA analyses were designed with respect to theoretical constructs and attenuating multicollinearity. For these MANOVA analyses, Where $P = 8$, the recommended sample size for the smallest group was $N = 48 – 80$. The third MANOVA analyses, which included reading skill is heuristic in nature since strategies specific to standardized reading tests were not measured (Stevens, 2002). For the third MANOVA analysis, Time 2 strategies and all other reading comprehension measures were excluded. For the third MANOVA analysis, where $P = 7$, the recommended sample size for the smallest group is $N = 42 – 70$.

Table 49

MANOVA Variables for Research Question 3

	First MANOVA	Second MANOVA	Third MANOVA
Variables	Time 2 Incremental Beliefs	Time 2 Incremental Beliefs	Time 2 Incremental Beliefs
	Time 2 Mastery-approach	Time 2 Mastery-approach	Time 2 Mastery-approach
	Time 2 Mastery-avoidance	Time 2 Mastery-avoidance	Time 2 Mastery-avoidance
	Time 2 Performance-approach	Time 2 Performance-approach	Time 2 Performance-approach
	Time 2 Performance-avoidance	Time 2 Performance-avoidance	Time 2 Performance-avoidance
	Time 2 Reading efficacy	Time 2 Reading efficacy	Time 2 Reading efficacy
	Time 2 Strategy Use	Paraphrase Strategy	Time 2 Reading Skill
	Time 2 Total RC Score	RC at Textbase	
Recommended Sample Size	$N = 48 – 80$	$N = 48 – 80$	$N = 42 – 70$

The results for assumptions 9 and 10 are presented separately for each MANOVA model.

Results of First MANOVA

Part one of the third research question was as follows: Does a growth-mindset intervention influence learners' endorsement of intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes? Specifically,

1. Compared to the control group, the growth-mindset intervention group will have stronger Time 2 incremental beliefs about intelligence.
2. Compared to the control group, the intervention group will have stronger Time 2 mastery-approach achievement goals.
3. Compared to the control group, the intervention group will have weaker Time 2 mastery-avoidance achievement goals.
4. Compared to the control group, the intervention group will have weaker Time 2 performance-approach achievement goals.
5. Compared to the control group, the intervention group will have weaker Time 2 performance-avoidance achievement goals.
6. Compared to the control group, the intervention group will have greater Time 2 reading efficacy.
7. Compared to the control group, the intervention group will have a greater Time 2 reading comprehension strategy use scores.
8. Compared to the control group, the intervention group will have greater total reading comprehension scores.

The ninth assumption requiring homogeneity of the covariance matrices assessed whether or not the separate and combined variances of each dependent variable, for each group, are statistically equivalent (Stevens, 2002). Since equality of variance is desired, a non-significant result is the ideal. For these data, there are eight dependent variables. The eight predictor variances for both treatment condition groups must be equal, and the 28 predictor covariances for each group must be equal. For the first MANOVA, the Box *F* test indicates that the assumption of homogeneity of the covariance matrices is met (M = 64.852, F (36, 34282.624) = 1.655, p = .008). Huberty and Petoskey (2000) suggest that significance is met for the Box *F* test at p = .005. Furthermore, violation of this assumption is problematic when group sizes differ substantially, such that one treatment group is at least twice the size of another (Huberty & Olejnik, 2002). Although group sizes differ for these data, the difference is not substantial.

The tenth assumption, homogeneity of variance, is crucial for interpreting and determining the robustness of the results of MANOVA. Levene's test statistic reports whether or not the error variance for each predictor variable is equal across groups. Since MANOVA calculations rely on the ratio of between-groups variance to within-groups variance, unequal variances can result in bias (Field, 2015). A non-significant statistic is the ideal result. For the first MANOVA, results from Levene's test of the equality of error variances showed that the assumption of homogeneity of variance was met with $p >$ .05 for all dependent variables.

For the first MANOVA, 65 cases were rejected because of missing data, resulting in N = 109, n = 61, and n = 48 for the control and growth-mindset treatment groups, respectively. The results of the omnibus hypothesis test of the equality of means for learners' endorsement of Time 2 intelligence and Time 2 motivational beliefs, use of Time 2 reading comprehension strategies, and total reading comprehension scores indicated insufficient evidence to reject the null hypothesis (Wilk's $\Lambda = 0.909$, F (8, 100) = 1.252, $p = .28$).

Results of Second MANOVA

Part two of the third research question was as follows: Does a growth-mindset intervention influence learners' endorsement of intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes? Specifically,

1. Compared to the control group, the growth-mindset intervention group will have stronger Time 2 incremental beliefs about intelligence.

2. Compared to the control group, the intervention group will have stronger Time 2 mastery-approach achievement goals

3. Compared to the control group, the intervention group will have weaker Time 2 mastery-avoidance achievement goals.

4. Compared to the control group, the intervention group will have weaker Time 2 performance-approach achievement goals.

5. Compared to the control group, the intervention group will have weaker Time 2 performance-avoidance achievement goals.

6. Compared to the control group, the intervention group will have greater Time 2 reading efficacy.

7. Compared to the control group, the intervention group will use more surface-level reading comprehension strategies.

8. Compared to the control group, the intervention group will have stronger reading comprehension at the textbase.

For the second MANOVA, the Box F test indicated that the assumption of homogeneity of the covariance matrices was violated ($M = 67.689$, F (36, 34151.046) = 1.727, $p = .004$). As discussed above, violation of this assumption is problematic only when group sizes differ substantially. Consequently, the robustness of the MANOVA was relied upon to test these data (Field, 2015; Huberty & Olejnik, 2002).

For the second MANOVA, results from Levene's test of the equality of error variances showed that the assumption of homogeneity of variance was met with $p > .05$ for the eight dependent variables.

For the second MANOVA, 66 cases were rejected because of missing data, resulting in $N = 108$, $n = 60$, and $n = 48$ for the control and growth-mindset treatment groups, respectively. The results of the omnibus hypothesis test of the equality of means for learners' endorsement of Time 2 intelligence and Time 2 motivational beliefs, use of paraphrasing reading comprehension strategies, and Time 2 textbase reading comprehension scores indicated insufficient evidence to reject the null hypothesis (Wilk's $\Lambda = 0.886$, $F(8, 99) = 1.594$, $p = .14$).

Results of Third MANOVA

Part three of the third research question was as follows: Does a growth-mindset intervention influence learners' endorsement of intelligence, motivational beliefs, and academic outcomes? Specifically,

1. Compared to the control group, the growth-mindset intervention group will have stronger Time 2 incremental beliefs about intelligence.

2. Compared to the control group, the intervention group will have stronger Time 2 mastery-approach achievement goals.

3. Compared to the control group, the intervention group will have weaker Time 2 mastery-avoidance achievement goals.

4. Compared to the control group, the intervention group will have weaker Time 2 performance-approach achievement goals.

5. Compared to the control group, the intervention group will have weaker Time 2 performance-avoidance achievement goals.

6. Compared to the control group, the intervention group will have greater Time 2 reading efficacy.

7. Compared to the control group, the intervention group will have greater Time 2 reading skill scores.

For the third MANOVA, the Box F test indicated that the assumption of homogeneity of the covariance matrices was violated ($M = 54.173$, F (28, 69498.902) = 1.836, $p = .004$). As discussed above, violation of this assumption is problematic only when group sizes differ substantially. Consequently, the robustness of the MANOVA was relied upon to test these data (Field, 2015; Huberty & Olejnik, 2002).

For the third MANOVA, results from Levene's test of the equality of error variances showed that the assumption of homogeneity of variance was met with $p > .05$ for the seven dependent variables.

For the third MANOVA, 24 cases were rejected because of missing data, resulting in $N = 150$, $n = 83$, and $n = 67$ for the control and growth-mindset treatment groups, respectively. The results of the omnibus hypothesis test of the equality of means for learners' endorsement of Time 2 intelligence, Time 2 motivational beliefs, and Time 2 reading skill scores indicated insufficient evidence to reject the null hypothesis (Wilk's $\Lambda = 0.927$, F (7, 142) = 1.602, $p = .14$).

Although MANOVA is considered to be a robust test, when the sample size is small, as was the case for this research, insufficient power for the MANOVA to reject the null hypothesis may be problematic. One way to improve the power of multivariate analyses when the sample size is small is to incorporate covariates to reduce the within-group error variance by conducting a multivariate analysis of covariance (MANCOVA). Covariates that are most influential for improving the power of multivariate tests are those that share significant correlations with predictor variables and low correlations with other covariates (Stevens, 2002). A MANCOVA was conducted for each of the three MANOVA models discussed above.

The following nine assumptions for using MANCOVA were validated:

1. Two or more continuous dependent variables (i.e., interval or ratio level)
2. Two or more categorical, independent groups
3. Independence of observations or random sampling
4. Adequate sample size such that the smallest group size is at least six times the number of predictors
5. Multivariate normality. Univariate normality and bivariate scatter plots were used to test this assumption.
6. No univariate or multivariate outliers. Cook's distance and scatterplots tested this assumption.
7. Linear relationship between each pair of dependent variables (i.e., they were correlated). SPSS split file command and a scatterplot matrix were used to test this assumption.
8. No multicollinearity assessed by VIF tested for multicollinearity.
9. Homogeneity of regression hyperplanes assessed by SPSS syntax for a simple MANOVA including the respective predictor variables and covariates.

In an attempt to improve the statistical power of the MANOVA, explanatory variables (i.e., covariates) were added to the model to reduce the unexplained error variance (Huberty & Olejnik, 2006; Stevens, 2002). Covariates and predictor variables should be theoretically bound to each other in order to improve the likelihood of meeting the assumption that the two sets of variables are significantly related to each other (Stevens, 2002). In addition, covariates should not be highly correlated with each other. When covariates are highly correlated with each other, the degree of their inter-correlation reduces their explanatory power within the model (Huberty & Olejnik, 2006).

For this research, all Time 1 measures that were repeated at Time 2 (i.e., Time 1 incremental beliefs, the four Time 1 achievement goals, Time 1 reading efficacy, Time 1 strategy use, and Time 1 reading skill) and prior knowledge were evaluated as potential covariates since they were theoretically bound to the dependent variables. Time 1 performance-avoidance was not included because it was highly correlated with performance-approach (r = .637). Time 1 mastery-avoidance was excluded because beyond Time 2 mastery-avoidance, its other correlations with Time 2 variables were relatively weak. This was the case for Time 1 strategy use, as well. The lack of correlation between Time 1 strategy use and the dependent variables was probably due to the low range of scores for Time 1 strategy use; however, due to its centrality to this research, Time 1 strategy use was retained for further analyses. Prior knowledge (of linguistics) was only included in the first and second MANCOVAs. It was excluded from the third MANCOVA because there was no theoretical basis for its inclusion.

The first assumption of MANCOVA was met. Eight continuous dependent variables were included in the first and second MANCOVA, and seven were included in the third MANCOVA. Validation of the second through fifth assumptions was discussed above.

Sixth, the assumption of no multivariate outliers was validated using SPSS regression procedure and selecting Cook's distance statistics. Cook's D was assessed for the eight predictor variables, prior knowledge, and the six remaining Time 1 covariates under consideration (i.e., Time 1 incremental, Time 1 mastery-approach, Time 1 performance-approach, Time 1 reading efficacy, Time 1 strategy use, and Time 1 reading skill). For these data, Cook's distance ranged from 0.000 to 0.077 (M = 0.014, SD = 0.013). A scatterplot of Cook's distances was created to view the values graphically using case numbers as the *x*-axis. Based on Cook's distance and visual inspection of the scatterplot, there were no multivariate outliers.

Seventh, data linearity was assessed using the procedure described above. The SPSS graph chart builder function was used to construct a scatterplot matrix of the seven covariates under consideration and the 11 predictors. The best fit method was specified as Loess to 90% of the data points. Results of the visual inspection indicated that the relationship between each pair of the 11 predictor variables and five of the seven covariates approximated linearity within the growth-mindset treatment and control conditions. However, Time 1 reading efficacy had non-linear relationships with Time 2 intelligence and the four Time 2 achievement goal variables. Also, Time 1 strategy use had non-linear relationships with Time 2 strategy use, paraphrase strategy, total reading comprehension score, and reading comprehension at textbase. Consequently, Time 1 reading efficacy and Time 1 strategy use were excluded from the MANCOVA analyses.

Eighth, multicollinearity was assessed by conducting an additional VIF analysis for five remaining covariates (i.e., Time 1 incremental, Time 1 mastery-approach, Time 1 performance-approach, Time 1 reading skill, and prior knowledge). Treatment condition was included as the independent variable. This analysis was conducted to validate that the covariates were not highly correlated to the point where their explanatory power overlapped. Multicollinearity was not evident among the covariates, with all *VIF* < 1.5.

Table 50 summarizes the predictors and the handling of all covariates for each MANCOVA model.

Table 50

Summary of MANCOVA Predictors and Covariates

	MANCOVA-1	MANCOVA-2	MANCOVA-3
Predictor Variables	Time 2 Incremental Beliefs	Time 2 Incremental Beliefs	Time 2 Incremental Beliefs
	Time 2 Mastery-approach	Time 2 Mastery-approach	Time 2 Mastery-approach
	Time 2 Mastery-avoidance	Time 2 Mastery-avoidance	Time 2 Mastery-avoidance
	Time 2 Performance-approach	Time 2 Performance-approach	Time 2 Performance-approach
	Time 2 Performance-avoidance	Time 2 Performance-avoidance	Time 2 Performance-avoidance
	Time 2 Reading efficacy	Time 2 Reading efficacy	Time 2 Reading efficacy
	Time 2 Strategy Use	Paraphrase Strategy	Time 2 Reading Skill
	Time 2 Total RC Score	RC at Textbase	
Selected Covariates	Time 1 Incremental Beliefs	Time 1 Incremental Beliefs	Time 1 Incremental Beliefs
	Time 1 Mastery-approach	Time 1 Mastery-approach	Time 1 Mastery-approach
	Time 1 Performance-approach	Time 1 Performance-approach	Time 1 Performance-approach
	Prior Knowledge	Prior Knowledge	Time 1 Reading Skill
Excluded Covariates	Time 1 Entity [a]	Time 1 Entity [a]	Time 1 Entity [a]
	Time 1 Mastery-avoidance [b]	Time 1 Mastery-avoidance [b]	Time 1 Mastery-avoidance [b]
	Time 1 Performance-avoidance [a]	Time 1 Performance-avoidance [a]	Time 1 Performance-avoidance [a]
	Time 1 Reading efficacy [c]	Time 1 Reading efficacy [c]	Time 1 Reading efficacy [c]
	Time 1 Strategy Use [b c]	Time 1 Strategy Use [b c]	Time 1 Strategy Use [b c]

Note. [a]Covariate excluded due to multicollinearity. [b]Covariate excluded due to lack of correlation with predictor variables. [c]Covariate excluded due to violation of multivariate linearity.

Assessment of the ninth assumption along with MANCOVA results are presented separately for each MANCOVA model.

The first MANCOVA tested whether, after accounting for Time 1incremental beliefs, Time 1 mastery-approach, Time 1 performance-approach goals, and Time 1 prior knowledge, a growth-mindset intervention influenced learners' endorsement of intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes.

- Null Hypothesis: $H_0 : \mu_{1_{Y/X}} = \mu_{2_{Y/X}}$
- Alternate Hypothesis: $H_0 : \mu_{1_{Y/X}} \neq \mu_{2_{Y/X}}$

Specifically,

1. Compared to the control group, the growth-mindset intervention group will have stronger Time 2 incremental beliefs about intelligence.
2. Compared to the control group, the intervention group will have stronger Time 2 mastery-approach achievement goals.
3. Compared to the control group, the intervention group will have weaker Time 2 mastery-avoidance achievement goals.
4. Compared to the control group, the intervention group will have weaker Time 2 performance-approach achievement goals.
5. Compared to the control group, the intervention group will have weaker Time 2 performance-avoidance achievement goals.
6. Compared to the control group, the intervention group will have greater Time 2 reading efficacy.

7. Compared to the control group, the intervention group will have a greater Time 2 reading comprehension strategy use scores.

8. Compared to the control group, the intervention group will have greater total reading comprehension scores.

For the first MANCOVA, SPSS syntax for a simple MANOVA with covariates was used to test the ninth assumption, homogeneity of the regression hyperplanes. The regression hyperplanes represent the collective adjustment that covariates make to the mean to reduce the error variance (Stevens, 2002). This assumption tests whether the estimates of the covariates for the predictor variables are the same at all points for both treatment groups. For this data, a violation of this assumption could result in an interaction affect, whereby the control group appears to outperform the growth-mindset treatment group at one level of the combined covariates, but at another level of the combined covariates the growth-mindset group appears to outperform the control group. Consequently, the SPSS design command was used to request a test of the interaction effect for the covariates by group. The desired outcome is to have a non-significant interaction effect of p = .05 or greater (Stevens, 2002).

For the first MANCOVA, the multivariate interaction effect test for the equality of the regression hyperplanes indicated that the regression hyperplanes were homogenous (Wilk's $\Lambda = 0.755$, F (32, 311.37) = 0.769, $p = .81$). SPSS syntax was also used to request a test of the vector of regression slopes for the predictors and covariates. This test provided supporting information regarding linearity of the covariates and predictor variables. A significant relationship is desirable, with $p < .05$. Test of the relationship between the covariates and the predictor variables confirmed that there was a relationship between the covariates and each dependent variable (Wilk's $\Lambda = 0.151$, F (32, 326.12) = 6.834, $p < .001$, $\eta^2 = .377$ (*adjusted* $R^2 = .364$)). In this case, *Adjusted* R^2 was calculated as follows:

$$R^2_{adj} = 1 - \left[\frac{(1 - R^2)(n-1)}{n-k-1} \right]$$

Inclusion of the covariates led to a slight decrease in the sample size. For the first MANCOVA, 73 cases were rejected because of missing data, resulting in $N = 101$, $n = 56$, and $n = 45$ for the control and growth-mindset treatment groups, respectively. The group size for the growth-mindset treatment condition was slightly below the recommended sample size (i.e., at least $n = 48$). Results of the omnibus hypothesis test, however, indicated there was sufficient evidence to reject the null hypothesis (Wilk's Λ = 0.821, F (8, 88) = 2.402, $p = .02$, $\eta_p^2 = .179$). After accounting for Time 1 incremental beliefs, Time 1 mastery-approach, Time 1 performance-approach goals, and prior knowledge, learners in the control and growth-mindset treatment groups differed with regard to the combined effect of their endorsement of Time 2 incremental intelligence and Time 2 motivational beliefs, use of Time 2 reading comprehension strategies, and total reading comprehension scores.

Since MANCOVA is an omnibus test, when significant results are produced, discriminant descriptive analyses (DDA) are required to obtain specific information regarding group differences among the various dependent variables to ascertain why the null hypothesis was rejected (Warne, 2014). DDA is a follow-up hoc multivariate statistical procedure so the assumptions of MANOVA apply to its dependent variables. In addition, the grouping variable must represent distinct levels, such that all cases exclusively belong to one group (Brace, Kemp, & Snelgar, 2013). All of the assumptions of DDA were validated in the previous multivariate analyses procedures.

DDA for MANCOVA was performed in SPSS utilizing the syntax for the MANOVA command and DISCRIM subcommand. In order to determine the patterns and magnitude of the contribution of each predictor variable, several of the tables produced from the DDA must be interpreted. First, the standardized discriminant function coefficients are displayed for each predictor. Together, the standardized discriminant coefficients are referred to as a discriminant function, and they operate much like a regression equation. For instance, the standardized discriminant coefficients can be used to construct a linear discriminant function (also referred to as LDF) or predictive rule for the MANCOVA model (Stevens, 2002). This is accomplished by summing the products of each predictor's adjusted mean value and its respective standardized discriminant coefficient. The summed product is referred to as a linear discriminant function score.

In addition, the standardized coefficients can be used to estimate the discriminant score for a particular case. Accordingly, scores may be used to predict group membership. Standardized discriminant functions, rather than raw discriminant functions, were requested in SPSS for these data because the dependent variables are measured on a variety of dissimilar scales (Grice & Iwasaki, 2007). Unlike raw coefficients, the standardized coefficients are derived from *z*-scores, which level the scales and allow for comparisons of the coefficients.

Second, the DDA also produced structure coefficients for each dependent variable included in the model. DDA structure coefficients reflected the correlations between each dependent variable and the linear discriminant function score. The product of the standardized discriminant coefficient and the structure coefficient for each dependent variable, respectively, yields the parallel discriminant ratio coefficient for each dependent variable. The parallel discriminant ratio coefficient (*PDRC*) is used to determine which variable is most influential for distinguishing among the groups (Warne, 2014).

As discussed above, results of the first MANCOVA indicated that after accounting for the covariates, there was sufficient evidence to reject the null hypothesis (Wilk's $\Lambda = 0.821$, $F\ (8, 88) = 2.402$, $p = .02$, $\eta_p^2 = .179$).

Discriminant analyses were conducted in SPSS using the procedure described above. DDA produced one function for these data (g-1). Table 51 provides a summary of the standardized discriminant function, group adjusted mean centroids for each predictor variable (i.e., after controlling for the covariates), the linear discriminant function components, and the linear discriminant function scores for the first MANCOVA. Using the standardized discriminant coefficients, a multivariate composite was written and computed as follows:

The first MANCOVA Composite = (Time 2 Incremental)(0.216) + (Time 2 Mastery-approach)(-1.059) + (Time 2 Mastery-avoidance)(0.010) + (Time 2

Performance-approach)(0.129) + (Time 2 Performance-avoidance)(0.756) + (Time 2 Reading efficacy)(0.170) + (Time 2 Strategy Use)(0.074) + (Total RC Score)(-0.385).

SPSS MANOVA command syntax was used to conduct a univariate ANCOVA on the first MANCOVA composite variable by treatment condition. Since standardized coefficients are used in composite, the multivariate composite was computed from the predictor and covariate *z*-scores (Grice & Iwasaki, 2007). Results indicated there was a significant effect of treatment condition on the multivariate composite (F (1, 95) = 20.59, $p < .001$, $\eta_p^2 = .178$).

Further examination of the standardized discriminant function coefficients indicated that most of the group variation was a function of mastery-approach goals. Specifically, if all other variables are held constant, a standard deviation increase on the mastery-approach goals scale would result in a 1.059 standard deviation decrease in the linear discriminant function score. Time 2 performance-avoidance and total reading comprehension score also appeared to contribute to between-group differences.

The discriminating influence of each dependent variable was validated by computing the product of the standardized discriminant function coefficients and the structure coefficients. Table 52 provides a summary of these data. The parallel discriminant ratio coefficients support the findings reported above. Mastery-approach by far is the greatest discriminator among the eight predictors (*PDRC* = .599), accounting for about 60% of the between-group variation. Time 2 performance-avoidance (*PDRC* = .254) and total reading comprehension scores (*PDRC* = .123) account for an additional

38% of the between-group variation. Collectively, these three predictors account for 98% of the difference between the control and growth-mindset treatment conditions.

Table 51

Summary of Discriminant Functions for First MANCOVA

Variables	Standardized Discriminant Function Coefficients	Group Adjusted Mean Centroids		Linear Discriminant Function Components	
		Control Group	Growth-Mindset Group	Control Group	Growth-Mindset Group
Time 2 Incremental	0.216	5.041	5.123	1.090	1.108
Time 2 Mastery-approach	-1.059	4.966	4.558	-5.260	-4.827
Time 2 Mastery-avoidance	0.010	4.030	4.194	0.041	0.043
Time 2 Performance-approach	0.129	4.731	4.644	0.610	0.599
Time 2 Performance-avoidance	0.756	4.406	4.763	3.331	3.601
Time 2 Reading efficacy	0.170	6.525	6.604	1.111	1.124
Time 2 Strategy Use	0.074	15.025	14.437	1.116	1.073
Total Reading Comprehension Score	-0.385	8.284	7.055	-3.188	-2.715
Linear Discriminant Function Scores				-1.147	0.006

Note. Linear discriminant function components are computed values (i.e., the product of the standardized discriminant function coefficients and group adjusted mean centroids). Linear discriminant function scores are computed values (i.e., the summed products of the standardized discriminant function coefficients and group adjusted mean centroids).

Table 52

Summary of Predictors' Discriminant Influence for First MANCOVA

Variable	Standardized Discriminant Function Coefficients	Structure Coefficients	Parallel Discriminant Ratio Coefficient
Time 2 Incremental Beliefs	0.216	0.147	0.032
Time 2 Mastery-approach	-1.059	-0.566	0.599
Time 2 Mastery-avoidance	0.010	0.146	0.002
Time 2 Performance-approach	0.129	-0.107	-0.014
Time 2 Performance-avoidance	0.756	0.336	0.254
Time 2 Reading efficacy	0.170	0.068	0.012
Time 2 Strategy Use	0.074	-0.095	-0.007
Total Reading Comprehension Score	-0.385	-0.319	0.123

Note. Parallel discriminant ratio coefficient is a computed value (i.e., the product of the standardized discriminant coefficient and the structure coefficient for each dependent variable).

Using the procedures described in Grice and Iwasaki (2007), a simplified multivariate composite was computed, whereby the three greatest contributors to the model were assigned a coefficient of 1 and all other predictors were assigned a coefficient of 0. The simplified MANCOVA multivariate composite = Time 2 mastery-approach (-1) + Time 2 performance-avoidance (1) + total reading comprehension score (-1), or Time 2 performance-avoidance – (Time 2 mastery-approach + total reading comprehension score). The simplified composite indicated that the difference between learners in the control and growth-mindset treatment groups was higher Time 2 performance-avoidance relative to Time 2 mastery approach and total reading comprehension score. Examination of the adjusted means shows that learners in the growth-mindset treatment group scored higher on Time 2 performance-avoidance and lower on Time 2 mastery approach and total reading comprehension scores, compared to the control treatment group.

The centrality of Time 2 performance-avoidance, Time 2 mastery approach, and total reading comprehension to discriminating between the control and growth-mindset treatment conditions was tested by conducting a follow-up MANCOVA including Time 1 incremental, Time 1 mastery-approach, Time 1 performance-approach, and Time 1 prior knowledge as covariates. Results confirmed that Time 2 performance-avoidance, Time 2 mastery approach, and total reading comprehension were the greatest discriminators of group differences (Wilk's $\Lambda = 0.912$, F $(3, 120) = 3.874$, $p = .01$, $\eta_p^2 = .088$). The estimated adjusted means for the control and growth-mindset treatment groups on the simplified MANCOVA are displayed in Figure 4.

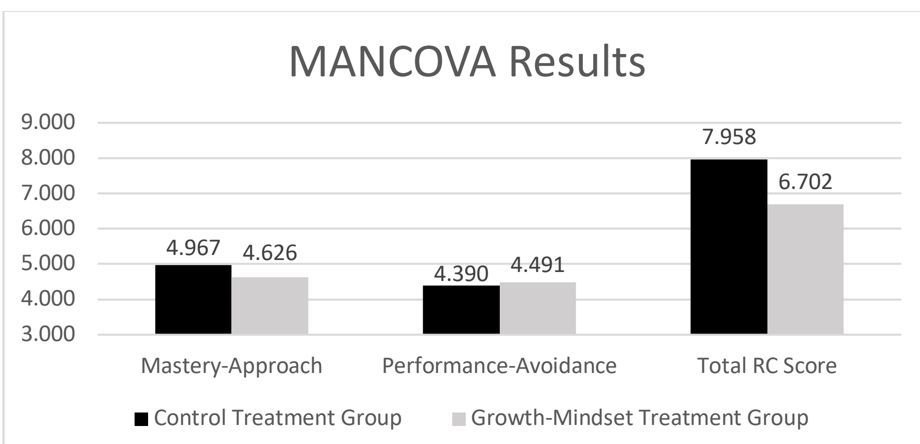

Figure 4. Means for control and growth-mindset treatment groups on simplified first MANCOVA.

Results of Second MANCOVA

The second MANCOVA tested whether after accounting for Time 1 incremental beliefs, Time 1 mastery-approach, Time 1 performance-approach goals, and Time 1 prior knowledge, a growth-mindset intervention would influence learners' endorsement of intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes.

- Null Hypothesis: H_0: $\mu_{1_{Y/X}} = \mu_{2_{Y/X}}$
- Alternate Hypothesis: H_0: $\mu_{1_{Y/X}} \neq \mu_{2_{Y/X}}$

Specifically,

1. Compared to the control group, the growth-mindset intervention group will have stronger Time 2 incremental beliefs about intelligence.
2. Compared to the control group, the intervention group will have stronger Time 2 mastery-approach achievement goals.
3. Compared to the control group, the intervention group will have weaker Time 2 mastery-avoidance achievement goals.
4. Compared to the control group, the intervention group will have weaker Time 2 performance-approach achievement goals.
5. Compared to the control group, the intervention group will have weaker Time 2 performance-avoidance achievement goals.
6. Compared to the control group, the intervention group will have greater Time 2 reading efficacy.
7. Compared to the control group, the intervention group will use more surface-level reading comprehension strategies.
8. Compared to the control group, the intervention group will have stronger reading comprehension at the textbase.

For the second MANCOVA, the multivariate interaction effect test for the equality of the regression hyperplanes indicated that the regression hyperplanes were homogenous (Wilk's $\Lambda = 0.731$, $F(32, 307.68) = 0.852$, $p = .70$).

The test of the relationship between the covariates and the predictor variables indicated there was a significant relationship between the covariates and each dependent variable (Wilk's $\Lambda = 0.147$, $F(32, 322.44) = 6.873$, $p < .001$, $\eta^2 = .381$ (*adjusted* $R^2 = .368$)).

Inclusion of the covariates led to a slight decrease in sample size. For the second MANCOVA, 74 cases were rejected because of missing data, resulting in $N = 100$, $n = 55$, and $n = 45$ for the control and the growth-mindset treatment groups, respectively. Sample size for the growth-mindset treatment group was below the recommended range. Results of the omnibus hypothesis test, however, indicated there was sufficient evidence to reject the null hypothesis (Wilk's $\Lambda = 0.817$, $F(8, 87) = 2.432$, $p = .02$, $\eta_p^2 = .183$). After accounting for Time 1 incremental beliefs, Time 1 mastery-approach, Time 1 performance-approach goals, and prior knowledge, learners in the control and growth-mindset treatment groups differed with regard to the combined effect of their endorsement of Time 2 incremental intelligence and Time 2 motivational beliefs, use of paraphrasing strategies, and textbase reading comprehension scores.

Discriminant analyses were conducted in SPSS using the procedure described for the first MANCOVA. DDA produced one function for these data (g-1). Table 53 provides a summary of the standardized discriminant function, group adjusted mean centroids for each predictor variable (i.e., after controlling for the covariates), the linear discriminant function components, and the linear discriminant function scores for the second MANCOVA. Using the standardized discriminant coefficients, a multivariate composite was written and computed as follows:

The second MANCOVA Composite = (Time 2 Incremental)(0.175) + (Time 2 Mastery-approach)(-0.993) + (Time 2 Mastery-avoidance)(0.027) + (Time 2 Performance-approach)(0.143) + (Time 2 Performance-avoidance)(0.678) + (Time 2 Reading efficacy)(0.143) + (Paraphrase Strategy)(0.025) + (RC Textbase)(-0.401).

SPSS MANOVA command syntax was used to conduct a univariate ANCOVA on the MANCOVA composite variable by treatment condition. Since standardized coefficients were used in composite, the multivariate composite was computed from the predictor and covariate *z*-scores (Grice & Iwasaki, 2007). Results indicated there was a significant effect of treatment condition on the multivariate composite (F (1, 94) = 20.86, $p < .001$, $\eta_p^2 = .182$).

Further examination of the standardized discriminant function coefficients indicated that most of the group variation was a function of mastery-approach goals. Specifically, if all other variables are held constant, a standard deviation increase on the Time 2 mastery-approach goals would result in a 0.993 standard deviation decrease in the linear discriminant function score. Time 2 performance-avoidance and reading comprehension at textbase also appeared to contribute to between-group differences.

The discriminating influence of each predictor was validated by computing the product of the standardized discriminant function coefficients and the structure coefficients. Table 54 provides a summary of these data. The parallel discriminant ratio coefficients supported the findings that Time 2 mastery-approach was by far the greatest discriminator among the eight predictors (*PDRC* = .559), accounting for approximately 56% of the between-group variation. Time 2 performance-avoidance (*PDRC* = .222) and textbase reading comprehension (*PDRC* = .201) accounted for an additional 42% of the between-group variation. Collectively, these three predictors accounted for 98% of the difference between the control and growth-mindset treatment conditions.

Table 53

Summary of Discriminant Functions for Second MANCOVA

Variables	Standardized Discriminant Function Coefficients	Group Adjusted Mean Centroids: Control Group	Group Adjusted Mean Centroids: Growth-Mindset Group	Linear Discriminant Function Components: Control Group	Linear Discriminant Function Components: Growth-Mindset Group
Time 2 Incremental Beliefs	0.175	5.045	5.121	0.883	0.896
Time 2 Mastery-approach	-0.993	4.976	4.565	-4.941	-4.533
Time 2 Mastery-avoidance	0.027	4.029	4.195	0.107	0.112
Time 2 Performance-approach	0.143	4.739	4.649	0.676	0.663
Time 2 Performance-avoidance	0.678	4.412	4.765	2.990	3.229
Time 2 Reading efficacy	0.143	6.540	6.612	0.938	0.948
Paraphrase Strategy	0.025	13.501	13.008	0.331	0.319
RC Textbase	-0.401	3.977	2.873	-1.593	-1.151
Linear Discriminant Function Scores				-0.609	0.483

Note. Linear discriminant function components = the product of the standardized discriminant function coefficients and group adjusted mean centroids. Linear discriminant function scores = the summed products of the standardized discriminant function coefficients and group adjusted mean centroids.

Table 54

Summary of Predictors' Discriminant Influence for Second MANCOVA

Variables	Standardized Discriminant Function Coefficients	Structure Coefficients	Parallel Discriminant Ratio Coefficient
Time 2 Incremental Beliefs	0.175	0.134	0.023
Time 2 Mastery-approach	-0.993	-0.563	0.559
Time 2 Mastery-avoidance	0.027	0.146	0.004
Time 2 Performance-approach	0.143	-0.110	-0.016
Time 2 Performance-avoidance	0.678	0.328	0.222
Time 2 Reading efficacy	0.143	0.061	0.009
Paraphrase Strategy	0.025	-0.088	-0.002
RC Textbase	-0.401	-0.502	-0.201

Note. Parallel discriminant ratio coefficient = the product of the standardized discriminant coefficient and the structure coefficient for each dependent variable.

Using the procedures described above, a simplified multivariate composite was computed. Similar to the simplified multivariate composite computed for the first MANCOVA, the simplified second MANCOVA multivariate composite = Time 2 mastery-approach (-1) + Time 2 performance-avoidance (1) + textbase reading comprehension (-1), or Time 2 performance-avoidance – (Time 2 mastery-approach + textbase reading comprehension). The simplified composite indicated that the differences between learners in the control and growth-mindset treatment groups were attributed to higher Time 2 performance-avoidance relative to Time 2 mastery approach and textbase reading comprehension. Examination of the adjusted means showed that learners in the growth-mindset treatment group scored higher on Time 2 performance-avoidance and lower on Time 2 mastery approach and textbase reading comprehension, compared to the control treatment group.

The centrality of Time 2 performance-avoidance, Time 2 mastery approach, and total reading comprehension to discriminating between the control and growth-mindset treatment conditions was tested by conducting a follow-up MANCOVA including Time 1 incremental, Time 1 mastery-approach, Time 1 performance-approach, and Time 1 prior knowledge as covariates. Results confirmed that Time 2 performance-avoidance, Time 2 mastery approach, and total reading comprehension were the greatest discriminators of group differences (Wilk's $\Lambda = 0.905$, F (3, 118) = 4.126, $p < .01$, $\eta_p^2 = .095$). The estimated adjusted means for the control and growth-mindset treatment groups on the simplified MANCOVA are displayed in Figure 5.

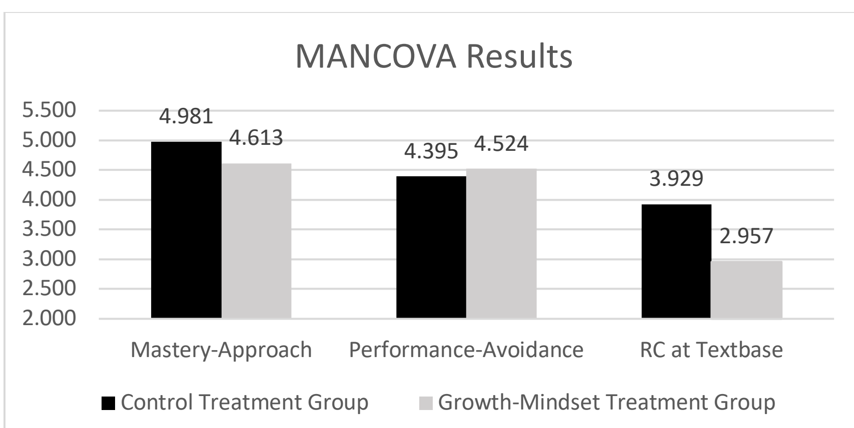

Figure 5. Means for control and growth-mindset treatment groups on simplified second MANCOVA.

Results for Third MANCOVA

The third MANCOVA tested whether after accounting for Time 1 incremental beliefs, Time 1 mastery-approach, Time 1 performance-approach goals, and Time 1 reading skill, a growth-mindset intervention would influence endorsement of Time 2 incremental intelligence, Time 2 motivational beliefs, and Time 2 reading skill.

- Null Hypothesis: $H_0 : \mu_{1_{Y/X}} = \mu_{2_{Y/X}}$
- Alternate Hypothesis: $H_0 : \mu_{1_{Y/X}} \neq \mu_{2_{Y/X}}$

Two MANCOVAs were tested for the third MANCOVA.

First, the model as presented above was tested. The multivariate interaction effect test for the equality of the regression hyperplanes indicated that the regression hyperplanes were homogenous (Wilk's $\Lambda = 0.860$, $F\ (28, 452.12) = 0.691$, $p = .88$).

A test of the relationship between the covariates and the predictor variables indicated there was a relationship between the covariates and each dependent variable (Wilk's $\Lambda = 0.309$, $F\ (28, 466.54) = 6.422$, $p < .001$). The uncorrected multivariate effect size was $\eta^2 = .255$ (*adjusted* $R^2 = .216$).

Inclusion of the covariates led to a slight decrease in sample size. For the third MANCOVA, 33 cases were rejected because of missing data, resulting in $N = 141$, $n = 78$, and $n = 63$ for the control and the growth-mindset treatment groups, respectively. The sample size was within the recommended range. Results of the omnibus hypothesis test, however, indicated there was not sufficient evidence to reject the null hypothesis (Wilk's $\Lambda = 0.908$, $F\ (7, 129) = 1.869$, $p = .08$). After accounting for Time 1 incremental beliefs, Time 1 mastery-approach, Time 1 performance-approach goals, and Time 1 reading skill, there was no significant difference in learners in the control and growth-mindset treatment groups with regard to the combined effect of their endorsement of Time 2 incremental intelligence, Time 2 motivational beliefs, and Time 2 reading skill scores.

Second, an attempt was made to improve the model by including four dummy variables to reflect race and ethnicity as covariates, in addition to Time 1 incremental, Time 1 mastery-approach, Time 1 performance-approach goals, and Time 1 reading skill. Race and ethnicity were included as control variables because educational researchers have long recognized that there is an intersection between social factors, including race and ethnicity, and achievement as measured by standardized testing (Ballantine, 1993; Wiggan et al., 2014).

The multivariate interaction effect test for the equality of the regression hyperplanes indicated that the regression hyperplanes were homogenous (Wilk's Λ = 0.650, F (56, 635.38) = 0.943, p = .59).

A test of the relationship between the covariates and the dependent variables indicated there was a relationship between the covariates and each dependent variable (Wilk's Λ = 0.259, F (56, 678.46) = 3.451, p < .001). The uncorrected multivariate effect size was $\eta_p^2 = .175$.

As discussed above, 33 cases were rejected because of missing data. Results of the omnibus hypothesis test, however, indicated there was not sufficient evidence to reject the null hypothesis (Wilk's Λ = 0.898, F (7, 125) = 2.028, p = .06). After accounting for Time 1 incremental beliefs, Time 1 mastery-approach, Time 1 performance-approach goals, Time 1 reading skill, and race and ethnicity, there was no significant difference between learners in the control and growth-mindset treatment groups with regard to the combined effect of their endorsement of Time 2 incremental intelligence, Time 2 motivational beliefs, and Time 2 reading skill scores.

Summary of Quantitative Findings

The first research question for the present study was as follows: Do motivational beliefs mediate the relationship between implicit theories of intelligence and reading comprehension strategy use? Five hypotheses were tested to examine how implicit beliefs about intelligence (Time 1) influenced reading comprehension strategy use (Time 2) via the four achievement goals and reading efficacy beliefs. Three models were tested for each hypothesis. The null hypotheses were retained for all but one model.

For the first research question, evidence was found to support the conclusion that mastery-approach goals (Time 1) significantly mediated the effects of incremental beliefs (Time 1) on reading comprehension strategy use (Time 2). The valence of the mediation, however, was not as expected. This finding, along with results showing that inclusion of the mediating variable (Time 1 mastery-approach goals) intensified rather than reduced the direct effect of Time 1 incremental beliefs on Time 2 reading comprehension strategy use, is evidence of the mediator having a suppression effect. Learners with higher incremental beliefs than their peers at Time 1 used fewer reading comprehension strategies at Time 2 as a result of maintaining higher mastery-approach goals at Time 1.

The second research question was as follows: Does reading comprehension strategy use mediate the relationship between motivational beliefs and achievement outcomes? Ten hypotheses were tested to answer this question. The first five hypotheses tested whether the four achievement goals and reading efficacy beliefs (Time 1) influenced (1) Time 2 reading comprehension by way of reading comprehension strategy use (Time 2). Three models were tested for each hypothesis. No evidence was found to support the hypotheses. The null hypothesis was retained for all models. For each *b*-path model, where Time 2 reading comprehension was regressed on reading comprehension strategy use (Time 2), the results showed that reading strategy use (Time 2) had a significant positive influence on reading comprehension scores (Time 2). In addition, unlike the four (Time 1) achievement goal variables, reading efficacy (Time 1) had a significant direct effect on reading comprehension (Time 2) in the first two models and a marginally significant effect in the third model, where reading efficacy (Time 1) was included as the independent variable. For all three models, the results for regressing total reading comprehension scores (Time 2) on reading efficacy (Time 1) showed that reading efficacy beliefs (Time 1) significantly (marginally for the third model) increased total reading comprehension score (Time 2).

Hypotheses 6 through 10 of the second research question tested how the four achievement goals and reading efficacy beliefs (Time 1) affected Time 2 reading skills by way of reading comprehension strategy use (Time 2). Three models were tested for each hypothesis. No evidence was found to support the hypotheses; thus, the null hypothesis was retained for all models. Similar to the results for the first five hypotheses tested, when strategy use (Time 2) was regressed on each of the motivational beliefs (Time 1), results showed that learners' motivational beliefs (Time 1) did not cause a significant increase or decrease in reading comprehension strategy use (Time 2). In contrast to the results for the first five hypotheses tested, results for path *b*, where Time 2 reading skill was regressed on reading comprehension strategy use (Time 2), showed that reading comprehension strategy use (Time 2) did not have a consistent significant positive effect on reading skill. There were no significant effects in any of the models where the independent variable was reading efficacy (Time 1). Finally, the results showed that controlling for strategy use and the respective covariates, mastery-avoidance goals (Time 1) significantly increased reading skill scores (Time 2) in all three models.

The third research question was as follows: Does a growth-mindset intervention influence learners' endorsement of intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes? Three MANCOVAs were conducted to answer this research question.

The first MANCOVA examined T1 incremental beliefs, T1 mastery-approach, T1 performance-approach, and prior knowledge as covariates; T2 incremental beliefs, the four T2 achievement goals, T2 reading efficacy, T2 strategy use, and T2 total reading comprehension score as dependent variables; and treatment condition as the independent variable. The MANCOVA-1 showed that after controlling for the covariates, there was a significant multivariate effect for the eight dependent variables by treatment condition (Wilk's $\Lambda = 0.821$, F $(8, 88) = 2.402$, $p = .02$, $\eta_p^2 = .179$). Discriminant descriptive analyses showed that after controlling for the covariates, 98% of the difference between the control and growth-mindset treatment groups was due to a function of T2 mastery-approach, T2 performance-avoidance, and total reading comprehension. The two groups differed by pattern such that learners in the growth-mindset treatment group scored higher on T2 performance-avoidance and lower on T2 mastery-approach and total reading comprehension scores when compared to the control treatment group. A follow-up MANCOVA-1 controlling for the covariates confirmed that T2 performance-avoidance, T2 mastery-approach, and total reading comprehension were the greatest discriminators of group differences (Wilk's $\Lambda = 0.912$, F (3, 120) = 3.874, $p = .01$, $\eta_p^2 = .088$).

The second MANCOVA examined T1 incremental beliefs, T1 mastery-approach, T1 performance-approach, and prior knowledge as covariates; T2 incremental beliefs, the four T2 achievement goals, T2 reading efficacy, paraphrasing strategy use, and reading comprehension at textbase as dependent variables; and treatment condition as the independent variable. Similar to MANCOVA-1, MANCOVA-2 showed that after controlling for the covariates, there was a significant multivariate effect for the eight dependent variables by treatment condition (Wilk's $\Lambda = 0.817$, F (8, 87) = 2.432, $p = .02$, $\eta_p^2 = .183$). Discriminant descriptive analyses showed that after controlling for the covariates, 98% of the difference between the control and growth-mindset treatment groups was due to a function of T2 mastery-approach, T2 performance-avoidance, and reading comprehension at textbase. Specifically, learners in the growth-mindset treatment group scored higher on T2 performance-avoidance and lower on T2 mastery-approach and reading comprehension at textbase when compared to the control treatment group. A follow-up MANCOVA-2 controlling for the covariates confirmed that T2 performance-avoidance, T2 mastery-approach, and total reading comprehension were the greatest discriminators of group differences (Wilk's $\Lambda = 0.905$, F (3, 118) = 4.126, $p < .01$, $\eta_p^2 = .095$).

The third MANCOVA examined T1 incremental beliefs, T1 mastery-approach, T1 performance-approach, and T1 reading skill as covariates; T2 incremental beliefs, the four T2 achievement goals, T2 reading efficacy, and reading skill as dependent variables; and treatment condition as the independent variable. After controlling for the covariates, MANCOVA-3 showed there was insufficient evidence to reject the null hypothesis (Wilk's $\Lambda = 0.908$, F (7, 129) = 1.869, $p = .08$). Controlling for the four covariates, the groups did not differ as a function of the eight dependent variables. A follow-up MANCOVA-3 was conducted to control for race and ethnicity, as well as the four initial covariates. Results of the follow-up MANCOVA-3 approached significance; however, there was not sufficient evidence to reject the null hypothesis (Wilk's $\Lambda = 0.898$, F (7, 125) = 2.028, $p = .06$). After controlling for T1 incremental beliefs, T1 mastery-approach, and T1 performance-approach goals, T1 reading skill, and race and ethnicity, the treatment groups did not differ as a function of their endorsement of T2 incremental intelligence, T2 motivational beliefs, and T2 reading skill scores.

Chapter 5

QUALITATIVE DATA ANALYSIS

Instructor Interviews

Instructor interviews were also conducted as a part of this research study. The initial purpose of the instructor interviews was to gather background information about the first-year course and to gain insights into learners' experiences working with the iSTART automated tutoring system. Later, the purpose of the interviews was expanded to follow up on interesting and unexpected observations that were made during the process of data collection. For instance, during the data-collection process, there was a noticeable difference in instructors' communication patterns regarding learners' engagement with this research. Specifically, Instructor 1 required multiple email notifications and phone calls before responding, Instructor 2 tended to respond promptly and would at times preemptively contact the researcher to inquire if students had completed assignments, and Instructor 3 shifted tactics during the semester, initially relying on the researcher to make contact with students but later taking the responsibility of following up with learners about their progress on iSTART tasks.

In addition, the timeliness of learners' completion of iSTART tasks tended to vary by instructor. As a result of these observations, analysis of the instructor interviews was expanded to include the following aspects of the study: (1) general background information about the first-year course, (2) instructors' perceptions of learners' academic engagement in the first-year course, (3) instructors' perceptions of learners' experiences working with the iSTART automated tutoring system, and (4) instructors' perceptions of learners' general college engagement.

The social cognitive perspective posits that learners' experiences in academic environments are influential and may be supportive of or a hinderance to beneficial intelligence and achievement motivation beliefs, strategic processing behaviors, and achievement outcomes (Balduf, 2009; Boretz, 2012). This chapter focuses on analyzing instructors' discourse to understand students' experiences within their respective learning environments, as well as exploring how the experiences within each learning environment are related to the quantitative results reported in the previous section.

Analysis Plan

Instructors participated in 75-minute face-to-face interviews as part of the present study. Prior to the interview, instructors gave informed consent and permission for the interviews to be audio-recorded. A transcription service was used to transcribe the interviews, and the primary investigator analyzed the data using Dedoose (Version 8.0.42). An iterative analysis process was used to analyze the data in order to identify any emergent themes in instructors' discourse. Iterative analysis is a cyclic process of capturing the specific ideas and concepts expressed by the participant and linking them to the ideas and concepts within the theoretical framework for the research (Tracy, 2013). The analysis plan for these data included primary coding, secondary coding, and synthesizing codes.

During the primary coding cycles, the transcripts were read several times and initial codes were assigned to capture the thematic essence of the instructors' discourse. Primary codes were close to the instructors' explicit statements (i.e., in vivo codes) (Strauss, 1987).

Interpretive second-level codes were created during the secondary coding cycles. These codes were used to organize and synthesize the qualitative data to identify patterns and construct interpretive meanings. Hierarchical codes were also used to acknowledge overarching concepts. The constant comparative method was used during the primary and secondary coding cycles to modify existing codes and create new codes to fit the data (Tracy, 2013). The primary and secondary coding cycles resulted in 417 coded excerpts.

Data synthesis, pulling together related codes to identify themes, was conducted throughout the coding cycles through the use of analytic memos, which are researchers' qualitative notes to self about the data. These notes may include, among other things, explicit descriptions of codes that specify examples, exceptions, and variations (Clarke, 2005). An informal analysis outline was created based upon the codes and analytic memos. The analysis outline was then organized by the research questions to identify any specific or loosely related primary- or second-level interpretive codes (Tracy, 2013). The most salient themes are discussed below with regard to their relevance to the research questions and quantitative results of this study.

This research explored the following three research questions:

1. Do motivational beliefs mediate the relationship between implicit theories of intelligence and reading comprehension strategy use?

2. Does reading comprehension strategy use mediate the relationship between motivational beliefs and achievement outcomes?

3. Does a growth-mindset intervention influence learners' endorsement of implicit intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes?

Analysis of Qualitative Data from Instructor Interviews

The qualitative analysis revealed two main themes regarding students' experiences within their respective first-year courses that are related to the three research questions for this study and the quantitative results reported in the previous chapter: (1) the messages communicated by the concepts and ideas instructors emphasized in the course, and (2) instructors' responses to students' resistance to completing course content, especially with regard to the iSTART training. The differences in the messages communicated to learners through the course content instructors emphasized and instructors' responses to learners who failed to meet course participation requirements may have impacted learners' motivational beliefs, as well as their strategic engagement with iSTART and achievement outcomes for this research. In the next section, an overview of the first-year course purpose is discussed. This discussion is intended to provide contextual information regarding the learning environments for this research. Afterward, the two themes regarding the impact of students' experiences that are related to the three research questions for this study and the quantitative results reported in the previous chapter are discussed.

First-Year Course Purpose and Instructors' Perspectives

The university designed the first-year course for the main campus to prepare beginning college learners to succeed academically and as individuals in society at large. The program places a strong emphasis on helping learners develop the requisite knowledge and skills to successfully advance toward degree completion. Specifically, the university's guidelines and learning outcomes require that all first-year courses incorporate instruction on university standards regarding ethics and academic honesty, responsible use of the Internet and social media, academic policies and procedures, diversity, and safety and wellness. On the main campus, learners in the first-year course also explore the following topics: (1) personal decision-making, (2) functioning as a contributing member of society, (3) planning for academic success, (4) critical thinking, (5) argumentation, and (6) aligning with a mentor. In addition, all beginning college learners are assigned a common reader, which is to be read before arriving on campus. The first-year course common reader is typically discussed during the second or third course meeting. Campus-wide activities and supplemental course discussions foster broader discourse among beginning college learners and culminate with a visit by the author.

For the AA Program, in addition to meeting the requirements of the university's guidelines and learning outcomes, instructors are encouraged to emphasize academic skills development to a greater degree than prescribed by the first-year course curriculum for the main campus. For instance, on the main campus, learners are provided with information about navigating university resources in order to access assistance with study skills. Conversely, for the AA Program, three course meetings are devoted to study skills development. Specific study skills topics include academic reading, notetaking, and test-taking. For this research, the three in-class meetings took place during meeting times that were reserved for teaching the aforementioned study skills. The following list details the topics scheduled to be taught in the AA Program first-year course to address the question, “How can I be a successful college student?”:

1. Goal-setting and time management
2. Study skills topic 1/reading comprehension (iSTART)
3. Sexual harassment colloquium
4. How professors grade (academic policies and procedures)
5. Study skills topic 2/reading comprehension (iSTART)
6. Midterm check-in; safety and wellness
7. Student conduct colloquium
8. Diversity and bystander intervention
9. Career services colloquium
10. Choosing a major (Review UDSIS, catalog, majors)
11. Study skills topic 3/reading comprehension (iSTART)
12. Group presentations
13. End-of-semester check-in; responsible use of social media

During the interviews, the instructors described the first-year course as multifaceted and having two purposes, both of which aligned with the researcher’s understanding of the first-year course at the AA Program. The primary purpose is to provide awareness of the university's policies, procedures, and standards, as well as knowledge of how to access university resources. The second purpose is to bolster learners' academic skills.

AA program instructors vocalized two primary purposes of the first-year course, specifically, to provide beginning college learners with requisite knowledge about the university and academic skill development. Instructors' perceptions of the purpose of the course to provide requisite skills and knowledge align with the university's intention for the course to familiarize learners with the university's academic policies and procedures.

Requisite knowledge about the university. Instructor 1 described the course's purpose as "[to get learners] tapped into knowledge and awareness [… for example] general knowledge of the university, policies and procedures, also, academic, like academics at large. What does it mean to have to have breadth requirements? What are they? At what point will they need to declare a major?" Instructor 1's thoughts on the purpose of the course also incorporated providing instruction on the university's specific guidelines and learning outcomes. This was evident in Instructor 1's statements that he or she "want[s] for the students to be introduced to the following topics: ethics and academic honesty, responsibilities of Internet and social media, academic policies and procedures, diversity and equity, safety and wellness."

Instructor 2 explained that "because we are, uh, categorized as a first-year course, we have to follow certain outcomes set by the university. Some of them are things like, students have to learn about what the sexual misconduct policy, student conduct policies [are]. Um, some academic skills, resources on all of those sorts of things." In addition to being aware that first-year courses have to adhere to certain guidelines, the instructor was also aware that the university's goal is to help learners succeed in society at large. Instructor 2 noted that the instruction he or she provided regarding the university standards was "the framework or rules of, like, this is how you conduct yourself, sort of, in a university. And hopefully, this is how you conduct yourself in life. 'Cause a lot of the things you learn about, especially sexual conduct policy, you know, that is applicable to not just college but, but everywhere else."

Unlike the other instructors, Instructor 3 did not explicitly articulate the university's specific guidelines and learning outcomes beyond saying, "We all have one curriculum that we follow, but we throw some extra things in there, as well. [...] For my kids specifically, I work on getting them familiar with the university website and getting familiar with how to find curriculum on the website. Being able to find their own or control their own schedules from here until they graduate." While the university's guidelines and learning outcomes attend to ethical considerations, responsible use of technology and maintaining a positive digital presence, conveying important policies and procedures, and the value of diverse perspectives and cultures, Instructor 3's discourse asserted that the most salient points for the AA Program course are to provide instruction on the resources that support academic success. It is important to note that Instructor 3's focus is a part of the university's broader focus on academic policies and procedures. In addition, the instructor noted that the AA Program shares one curriculum, and learners do receive instruction regarding ethics and academic honesty, responsible use of the Internet and social media, academic policies and procedures, diversity, and safety and wellness.

The understanding obtained from the learners' discourse, however, was that the instructor may not have viewed these other components as the principle purpose of the first-year course for learners in the AA Program.

In general, all instructors articulated that one purpose of the AA course is to provide beginning college learners with requisite knowledge about the university. While Instructor 1's and Instructor 2's perspectives clearly articulated the university's guidelines and learning objectives for the course, Instructor 3's response indicated a much narrower view of the university's expectations, although not divergent.

Academic skill development. The second purpose for the first-year course vocalized by the instructors, albeit to different degrees, is to support academic skills development. In general, this perspective aligns with the university's guidelines and learning objectives. The direct provision of academic skill instruction, however, diverges from the university guidelines. On the main campus, teaching these skills is not a part of the course curriculum. Rather, learners are instructed on how to access academic support resources. The observed differences between the main campus and the AA Program are due to the perceived needs of learners matriculating into the AA Program, particularly those whose high school academic records and/or college entrance exam scores indicate they are underprepared to succeed in a traditional 4-year college program.

While all instructors referred to academic skills development, just as they referred to conveying requisite knowledge about the university, instructors' discourse conveyed that this purpose was narrower for some than it was for others. For instance, Instructor 1 conveyed that he or she wanted "students to be introduced to […] enhancing study skills." While Instructor 1 went to great lengths to describe the university's guidelines and learning objectives, this statement was the only reference made about the purpose of the course to teach academic skill development. For Instructor 1, the social aspects of the university's guidelines and learning outcomes were more salient in terms of describing the course purpose than academic skills development.

Similarly, Instructor 2 explained that a "part of that [the course purpose] is helping them understand it's not a continuation of high school. College is, requires a different set of skills, part of those being academic skills." Instructor 1 and Instructor 2 seemed to have a shared understanding that while academic skill instruction is a part of the AA Program first-year course, it is not the primary focal part of the course as specified by the university.

In contrast, Instructor 3 described the course and its purpose as "a one-credit pass/fail course that is basically designed to teach study skills to the incoming freshmen." Unlike the other instructors, Instructor 3 saw the primary purpose of the course as to prepare beginning college learners in the AA Program for academic success by teaching them skills that they are most likely lacking. Instructor 3 went on to describe the skills the course is designed to teach, including "time management, goal setting, reading, test-taking, note-taking in class – Cornell notes specifically is what we teach." Instructor 3 also discussed why certain topics were included in the course purpose: "They [the students] need help with reading, they need help with studying. They literally don't know how, so we talk about how to break their work down, how to make an outline or make questions for themselves. We teach Cornell note-taking, which they all hate, and none of them do by the way, but we teach it to them."

In general, the instructors identified two purposes for the AA Program first-year course. Instructors' discourse, however, revealed that Instructors 1 and 2 perceived that although academic skill development is a part of the course's focus, it is a small part of a much larger focus. Conversely, while Instructor 3 stated that the topics are aligned with the university's guidelines and learning outcomes, he or she saw academic skill development as the primary purpose of the course. As discussed below, these differences in instructors' perspectives of the course's purpose guided their instructional emphasis and may have impacted learners' beliefs about intelligence and motivation, as well as their strategy use and achievement outcomes.

The Impact of Learning Environments on Motivational Beliefs, Reading Comprehension Strategy Use, and Achievement Outcomes

Quantitative results for the first research question do not align with Dweck (1999). Fourteen of the 15 models tested were null, and the only significant finding indicates that mastery-approach goals had an unexpected suppression effect on the direct relationship between Time 1 incremental beliefs and Time 2 reading comprehension strategy use. Results for the 30 models tested under the second research question also failed to align with Dweck (1999). The point of overlap for research questions 1 and 2 is the relationship between learners' achievement goals and strategic processing. Following this line of thought, one explanation for the preponderance of null results observed in this data is that learners' perspectives of the first-year course and iSTART influenced their willingness to fully engage with the iSTART training and practice. Linnenbrink-Garcia et al. (2008) suggest that participants' perspectives of task characteristics can influence their achievement behavior in ways that do not align with theoretical expectations. For instance, Darnon, Butera, and Harackiewicz, (2007) found evidence that mastery-approach goals only influenced learning when learners perceived that the learning environment provoked uncertainty regarding their understanding of the academic task. Qualitative evidence from the instructor interviews suggests that the learning environments may have communicated different messages and thus influenced the way learners engaged with iSTART tasks. In the following section, each instructor's emphasis is discussed. Afterward, the impact on learners' engagement with iSTART is discussed.

Instructional Emphasis

Although instructors' perceptions of the purpose of the AA Program first-year course were within the scope of the university's guidelines and learning outcomes and instructors were provided with guidelines about course topics, the instructional emphasis placed on specific concepts and ideas varied by instructor. For instance, Instructor 1 dedicated time during each course meeting to discuss the common reader, diversity, inclusion, and social justice, while Instructors 2 and 3 dedicated each course meeting to the course topics specified in the AA Program course schedule above.

Instructor 1. In accordance with the AA Program course schedule, Instructor 1 initially shared that each course meeting was devoted to one of the course topics. Later, it became apparent that students in Instructor 1's course sections were assigned one to two chapters of reading from the common reader each week, and a portion of each 50-minute course meeting throughout the semester was spent discussing the required course readings and current events. As discussed above, the common reader was intended to be read before learners arrived on campus and the campus-wide activities related to the reader typically conclude within the first four weeks of the semester.

Instructor 1 was heavily invested in issues pertaining to diversity, inclusion, and social justice. The instructor shared,

> From the very beginning, I focused on relating the reading material to current events. like, the common reader was about the internment of Japanese Americans during World War II, so we related that to terrorism in 2016. I found that […] the discussions were very engaging because I made them engaging and not necessarily about specific material in the book.

Furthermore, Instructor 1 wanted class meetings to be a time and place for sharing and making sense of differing perspectives on social and political issues. For instance, Instructor 1 stated,

> With the [2016 presidential] election, it gave them a very comfortable space to discuss it and to not be judged, so they were able to talk pretty upfront and honest about their opinions, and then we just unpacked it and I related it back to, like, "What is your experience as a person here, and in life?" One of my goals was to allow for a comfortable space for them to be comfortable talking about uncomfortable issues.

Instructor 1 also desired to ensure that students explored their thoughts about personal identity, particularly with respect to others. The instructor felt that emphasizing these aspects of diversity with regard to current social and political events filled a gap that otherwise would have been left unaddressed by other instructors at the university. While reflecting on classroom discussions, Instructor 1 shared the following:

> [The students were] very knowledgeable of the fact that the world is diverse around them, and they could describe how diverse it was, but they did not seem very comfortable with talking about diversity issues with each other. I explained to them that we're in a very unique position, because we're in the Associate [in] Arts program. It's different from the main campus. Our student population is very different, and that is worth some exploring, I think, but it's also a part of their awareness as students on a satellite campus who plan to go to the main campus. We have conversations about how best they could be prepared through their own identity […] to work through that before they get to the main campus and be aware of it. […] We talked in general about the impact that it had on our society at large, and on the interaction of people, on diversity, how we view diversity, and even multi-culturalism, how we viewed being an American, what that was like for them. I thought it was important, because a lot of their classes won't take the time to focus specifically on that. They seemed very comfortable. […] I had the very unique opportunity to walk with the students through the election process.

Instructor 2. Instructor 2's emphasis in the course was streamlined and very close to the prescribed course schedule for the AA Program described above. Unlike Instructor 1's course sections, where issues pertaining to the common reader and current events were discussed at each meeting, in Instructor 2's course sections, each meeting was devoted to a particular topic that aligned with the course description. Instructor 2 stated that for each class meeting, "there might be, just some, like, announcements about, 'There's a Career Fair coming up,' and all that, but generally speaking, it's all the central topic and with maybe, like, a tangential thing that's related to it." For example, with regard to diversity, "there was a whole lecture on talking about diversity. So, there's one whole, you know, one whole class meeting devoted to it. And I guess I wouldn't say that it was sort of broached again in other weeks."

Although Instructor 2 did not convey that academic skill development was the primary purpose of the first-year course, he or she still emphasized certain academic mindsets pertaining to academic skill development. Specifically, Instructor 2 communicated the importance of academic responsibility standards to students' success in college. The instructor reported that he or she frequently reiterated the message that "the expectation is, you know, you still gotta' go to class, you still have to submit your assignments, you still have to be, I guess, respectful to your professor." Instructor 2's message was intended to convey that academic expectations are constant and are not predicated on students' motivational or affective dispositions toward the course or instructor.

Instructor 3. Unlike Instructors 1 and 2, but in line with their perceptions of the course purpose, Instructor 3 emphasized academic skills, such as time management, study skills, and goal-setting. Instructor 3 shared that "I would want them to learn to manage their time because that's something that even I don't do well in adulthood." With regard to goal-setting, Instructor 3 shared personal insights into his or her own goal-setting processes to help students understand that the skills they were learning would be beneficial for life in and beyond college. Instructor 3 stated,

> I make them make a goal every semester and I make one with them. I'll say, "Okay, my SMART goal is that on Tuesdays and Thursdays when I'm stuck […on campus] where there's absolutely nothing to do [except] to procrastinate" […] and that's my SMART goal, because it's really very specific.

Another academic skill Instructor 3 emphasized was public speaking. Instructor 3 required all learners to do a final oral presentation "because statistics have shown that

[…] if a kid takes a public speaking course in their first two years of college, they are more successful academically in the last two years of college." Unlike the manner in which Instructor 1 emphasized diversity, Instructor 3 did not incorporate public speaking into other topics. Rather, the topic was taught during one course meeting and the public-speaking assignment was assigned as a long-term project. The instructor shared that "[public speaking is] a mini unit. It's not like taking a whole class on it, but I think it's a skill that they should become familiar with and to get them past that fear of it right away."

Similar to Instructor 2, Instructor 3 also emphasized specific academic mindsets to support the development of academic skills, such as taking personal responsibility for the progress of their academic careers. The instructor shared that he or she frequently directed learners to consider "Whose responsibility is it that you get the right education? It's yours. […] Be proactive for yourself and just essentially stop the high-school mentality."

In general, instructors differed in their instructional emphasis. While Instructor 1 focused on the common reader and issues pertaining to diversity by dedicating time to these tasks during course meetings, the other instructors devoted the allotted course meeting times to lessons on the specific topics that were scheduled. In the case of Instructor 3, who also had a particular topical interest, he or she limited the course time spent on public speaking to one session, while learners worked on the practice task independently as a long-term project. In addition, unlike Instructor 1, Instructors 2 and 3 also emphasized particular academic mindsets that they believed would support learners' development of academic skills and success in college.

Impact on learners' engagement with iSTART. The concepts and ideas emphasized in the AA Program first-year courses may have influenced learners' willingness to engage with iSTART. For instance, on average, learners in Instructor 1's course section took longer to complete iSTART tasks and completed fewer of the tasks compared to learners in the other course sections. Of interest is the fact that Instructor 1 expressed few thoughts on academic skill development as a purpose of the course and instead focused on engaging learners in group discussions about diversity. Learners were given the opportunity to share life experiences and reflect on current events. This opportunity was probably very meaningful for learners because this research was conducted during the 2016 presidential elections, which heightened racial and ethnic divides across the United States. Given that the instructor perceived that learners enjoyed the instructional focus of the course, and iSTART required learners to work independently on improving their reading comprehension skills, iSTART was most likely not seen as an appropriate fit for the implicit course purpose by the course participants. In fact, Instructor 1 conveyed that learners

> had kind of gotten used to the instruction and the ebb and flow of the class, that it was going to be like me speaking to them, or with them, in discussions and group work, or a guest speaker who was just going to speak about an office or what a department or something does. For iSTART, it was computer-based, and, like, quizzes, and just really different from what the classroom is, so they were like, "What? What is ...," kind of like a shock mode. They're like, "What are we doing again? This isn't what we signed up for."

In comparison, on average, learners in Instructor 2's course sections completed more iSTART tasks and completed them in a timelier manner. Similar to Instructor 1, Instructor 2's perception of the course purpose was that while academic skill instruction is a part of the AA Program first-year course, it is not the primary focal point. Unlike Instructor 1, however, Instructor 2 emphasized academic mindsets that may have motivated learners to thoughtfully complete the iSTART tasks. Specifically, Instructor 2's communication that academic expectations were not dependent upon motivational or affective dispositions toward the course or instructor may have protected learners against disengagement, particularly if they felt the tasks were not a fit for the course.

Learners in Instructor 3's course sections completed more iSTART tasks in a timely manner than learners in Instructor 1's course sections, but not more than the learners in Instructor 2's course sections. In terms of course purpose, Instructor 3 perceived that the course's purpose was primarily to provide academic skill development. On the surface, it appears that iSTART is a perfect fit for these course sections. It is possible, however, that the addition of iSTART to course sections where the course purpose was heavily weighted toward academic skill development served to further stigmatize learners, particularly those who had been denied immediate access to the main campus and were required to enroll in the AA Program (Aronson et al., 2002).

Instructor interviews provided evidence to suggest that instructors' emphasis on particular concepts and ideas may have influenced whether learners resisted, persisted, or disengaged with iSTART. Another area that influenced the manner in which learners interacted with iSTART was instructors' responses to learners' failure to complete course requirements.

The Impact of Learning Environments on Outcomes Related to the Growth-Mindset Intervention

Quantitative results for the third research question did not align with theoretical expectations (Dweck, 1999). Results showed that learners in the growth-mindset intervention group scored higher on T2 performance-avoidance and lower on T2 mastery-approach, total reading comprehension, and reading comprehension at textbase. As discussed above, participants' perspectives of task characteristics can influence the achievement behavior in ways that do not align with theoretical expectations (Linnenbrink-Garcia et al., 2008). In addition, instructors' instructional practices can influence whether learners disengage from, resist, or persist with academic tasks, as well as persistence in completing the research and iSTART training and practice tasks (Pascarella, Seifert, & Whitt, 2008). Qualitative evidence from the instructor interviews suggests that instructors' instructional practices may have communicated different messages, thereby influencing the quality of learners' engagement. In the following section, instructors' responses to learners' failure to complete course requirements is discussed. Afterward, the impact on learners' achievement motivation and engagement with iSTART is discussed.

Instructors' Responses to Learners' Failure to Complete Course Requirements

During the instructor interviews, instructors shared their perspectives of learners' thoughts about the first-year course and iSTART training. As indicated above, instructors' discourse indicated that students may have maintained differing thoughts about the purpose and value of the first-year course, as well as whether or not iSTART was an appropriate fit for the course and for their needs as college students. All the instructors expressed that they experienced some form of student resistance with regard to completing independent coursework, albeit to varying degrees. Finally, instructors' responses to students' resistance informed students of their instructor's flexibility with regard to fulfilling their academic responsibilities, and ultimately influenced the academic behaviors students adopted.

Instructor 1. In general, Instructor 1 conveyed that his or her learners expressed more resistance to coursework and iSTART than the other instructors did. Instructor 1 perceived that many students were resistant to participating and completing coursework. Instructor 1 stated that

> [C]onsistently, my students […] were looking for loopholes, like, "Do I have to? Do we really...?" and I was asked by some students, like, "Do we really have to read the book? Are we really going to talk about it every class? Well, what if we don't? Can we still pass the class and not have read the book?" They tended to be my students who, either verbally were looking for loopholes, or they would just kind of get by in the class. It was a mix of all of that.

In addition, Instructor 1 felt that many learners often came unprepared to participate in scheduled class activities. When students came unprepared to class, Instructor 1 sought ways for all students to participate in class activities, even when students did not complete the required readings. Instructor 1 explained,

> [O]ftentimes, I would be able to figure it out, and […] I would try to say things that let them know that […] "I know you didn't read the book, but […] even if one did not read the book, you would be able to answer this question, so I'm going to call on a couple people, and I want you to give your feedback. How do the themes that we've discussed relate to current

> events?" Most times, we would have talked about current events already, and I would write on the board, so […] the themes would be on the board, so, "Pick a topic that's on the board already, and how do you think the book relates to it?" […] For most of the students who did not do the work or didn't have that diligence, they would just not, they would do it just enough in class and nothing at all outside of class, so while they're within our glance and grasp, they would do enough so that we wouldn't be on them, but then, outside of class, they weren't going to do it at all, unfortunately.

When Instructor 1 retrospectively reflected on the aforementioned strategy to encourage class participation, he or she recognized that this strategy may have encouraged students to consistently not complete the course readings. Instructor 1 mused, "I think […] it might have worked against me, because we could, like, they could come to class and talk about current events or to wait and listen to other people talk about the book and then relate it, relate what they hear, versus relating what they read." In response to learners' failure to complete the required coursework, and in an attempt to induce class participation, Instructor 1 unintentionally compromised the academic standards of the course. This practice communicated to learners that they were not going to be held accountable for completing assignments.

As stated above, students in Instructor 1's course sections were also resistant to completing the iSTART training. According to Instructor 1, resistance among students in the course mounted as they began to work on the iSTART training modules. Instructor 1 recounted,

> Initially, it was like, "Oh, gosh, what is this? Is this manda-?" Then it went, it sent them back to the same questions they had about the pass/fail class, like, "Well, what parts of this are mandatory? What do I have to do? What don't I have to do? What can I do that's just enough to pass?" I found, even for some students who

> were dedicated to the [common reader] readings were still like, “So, do we have to do this? Do we really? I have to do it?”

The scope of students’ resistance to completing the iSTART tutorial in Instructor 1’s course sections became evident after the first practice text assignment was due. The iSTART platform enabled the researcher (and the instructors) to track class progress on the tutorials and assignments. According to the visible data, none of the students in Instructor 1’s course sections had fully completed the iSTART tutorials. Student progress ranged from zero to 75% completion of the tutorial modules. Instructor 1 was made aware of the situation and agreed to remind students that they needed to complete the iSTART tutorials and practice assignments.

Instructor 1 indicated that there was a resurgence of vocalized resistance when participating students were reminded that they needed to complete the iSTART training and that their progress was visible and being tracked in iSTART:

There was a lot of, \”Do we have to do this?” […] “What parts of this do we have to do?” I got questions about the practice sections versus the actual quiz sections, versus the more fun, the games, and they just wanted to know, “Well, what if I just want to do the games?” They seemed more fun, but we knew, and we kept telling them, like, “There are certain things that you absolutely need to get done, and then if you want to play the games, feel free to play as many as you want.” Their questions were mainly like, “Do we have to do this?” and, “What do we have to do in order to pass the class, or in order to pass the iSTART program?”

Interestingly, students' expression of the goal of "just getting by," seemed to be limited to completing iSTART and their enrollment in the first-year experience course. Although no information was ascertained about students' academic behavior in other courses, learners did express a desire to earn high grades (i.e., A's and B's) in the graded courses they were taking.

Instructor 2. Instructor 2 believed that students' perceptions of the first-year experience were by and large predicated on their manner of engagement with the course. Those who completed assignments and actively participated in course discussions were likely to perceive the class as valuable. Instructor 2 stated,

> Um, my sense is that, it's sorta your typical curve, or like, the good students are going to appreciate it. Some of them, probably it's already like refresher or whatnot. Maybe the students who really need it, you know, they may not at the time appreciate it as much or find much value in it. So, they may not find the class, as a whole, as valuable. It's also, because it's only 50 minutes once a week, it's sorta like a, I think sometimes they just, people just don't show up. Like something they just have to show up to, and then, and then leave. Cause some students were very engaged […they'd come in with] a bunch of questions or come up with suggestions and topics, but others were just very, you know, corner of the room. Just […] 20 more minutes, 10 more minutes.

Instructor 2 did not experience substantial student resistance to completing assigned coursework. Instructor 2 reported "I felt like a pretty, you know, an amount to be expected, about 90% [of the students across the three course sections] completed assignments on time." This ratio played out even with regard to students' timely completion of the iSTART training and assigned practice texts. Although there were some slight differences among Instructor 2's course sections, the group as a whole was very efficient in completing assigned tasks. Learners' responsiveness and efficiency for completing assignments, including iSTART tasks, were supported by the manner in which Instructor 2 organized the course and communicated clear messages about course expectations. Instructor 2 was very organized and methodical about communicating assignments and deadlines, as well as with following up on missed assignments.

Instructor 2 underestimated their role in students' achievement behaviors and attributed the high level of student responsiveness for completing assignments to learners' newness to university and respect for "an authority figure." Other factors that may explain the high level of learner responsiveness include personally relevant assignments, a clear policy regarding the completion of assignments and a systematic method of following up with learners regarding their coursework.

First, Instructor 2 sought out ways to foster student engagement and connectedness to the course by tailoring activities to students' needs and interests, and demonstrating the utility of the skills taught in the course. Instructor 2 shared that "I try to make it relevant, as relevant as possible. So […] goal setting assignments, and they had to come up with two goals – one academic, one sort of personal goal for the semester. So, time management, we made a, I had them do a pretty much put all the dates from the syllabus into their planner. So, I try to make the assignments, you know, like useful assignments; not just busy work assignments."

Second, Instructor 2 consistently communicated a clear policy on expectations regarding students' participation in the course. Specifically, learners understood that their success in the course was dependent upon completion of all assigned coursework. Understanding this standard provided an incentive for them to complete their work.

Finally, Instructor 2 employed a learning management system to organize communications with learners and track their task completion. Instructor 2 was proactive in communicating with learners who were missing assignments or falling behind in completing assignments in iSTART. Instructor 2 used Canvas to communicate and took advantage of its features. For instance,

> [T]hey have a nice feature you know, if somebody doesn't submit an assignment, you could just choose like a drop-down menu and say email all students who have not submitted an assignment. And then I just put a message and then, it gets sent to them and then maybe the next week, I send another one and it'll automatically only include those who have not submitted it. So, some of them just needed one of those messages. Some others needed like multiple messages there. And, occasionally, I would send, if you do not turn this in, you will fail the course.

Instructor 3. For Instructor 3, students' responses to coursework and iSTART varied by course section. Instructor 3 noted that most of the voiced resistance regarding course work, including iSTART, came from the course section that met on Fridays. With regard to students' resistance, Instructor 3 stated,

> [T]hey were pissed that they were in there on a Friday at 1:00 and that has nothing to do with you, but you can let it be known that they were pissed about that all semester long. They used to never have classes on Fridays so when we had to put them on a Friday for me to be able to teach it, it wasn't just your stuff. It was from the minute they walk[ed] through the door. "Oh, I can't believe I'm here on a Friday." You think I want to be there on a Friday? Come on. That was a big deal for them and so they were doubly resistant to anything that we asked them to do including being there because it was Friday at 1:00. I don't know if that makes any difference to

you, but I do believe it made a difference… For a lot of them they didn't have any other classes that day at all because we don't have Friday classes… for the most part. They would just come specifically for that one thing. I think that that made a difference in the level of apathy or anger or whatever it was in them.

Instructor 3 felt that learners devalued the first-year experience course and iSTART. With regard to the first-year experience, Instructor 3 stated that “most of them think they don't need it and they think it's dumb, it's met with great resistance.” Despite believing that many learners reasoned that the first-year experience course was unnecessary, Instructor 3 also perceived that some learners attempted to explain their resistance to fully engaging with iSTART by complaining that it was taking time away from what they really should be learning. Instructor 3 shared that

> [Students] would say things like, "We could have been learning [...]" Here's the deal, whatever it was, I was going to be teaching them is what you were teaching them, so they would have been resistant when I was teaching it or if you were teaching it but what they were saying was, "Well we spent all that time doing that and we could have been doing other things." I think that they were [...] I have 14 weeks with them and three of those weeks go to mandatory seminars from the Main campus. They come down, they give them a speech and so then we don't have class that week. Three of the weeks went to iSTART, which is also perfectly fine. But that's literally almost half my time with them so I feel that they felt they didn't get enough from me. Does that make sense? I don't know what they wanted from me so here's the deal, they could say that all day long. We should have been focusing on other things that we really needed. What I would've literally been teaching them was reading and note-taking and then they would have thought that was dumb [...] I think they didn't think they got enough of me specifically which is not your fault […] most of them were irritated by it. [pause] They were irritated by everything I said.

Instructor 3 found that some students actively resisted completing assignments that extended beyond in-class time. This was particularly problematic for iSTART training because the training modules and practice texts were assigned as homework. Overall, Instructor 3 noted that there was a "50 to 75% rate of people who turn things in on time when they're supposed to, and the rest, you have to kind of hunt them down. Or not, and then you can fail them, but I don't like to do that."

In addition, it was difficult to get learners to respond to requests to turn in missing assignments. Instructor 3 stated that "They're not that receptive. You have to hunt them down. You've experienced this yourself with my students I'm sure […] I don't ask them to do really difficult things. I don't ask them to turn in even something every week… they're not receptive."

Students lack of receptivity seemed to play out along two pathways in Instructor 3's course sections, one leading to successful course completion and the second to possible course failure. Similar to the experiences of Instructor 1, Instructor 3 had a contingent of learners who risked failure because they perceived that Instructor 3 would sometimes compromise on academic standards. Instructor 3 noted,

> [S]ome of them they don't think they need the class, but they know they have to do the [work...] The rest are just like, "Oh I don't have to do that because then I'll just tell her I couldn't do it because of this and she'll pass me anyway." There's a lot of, none of them think they're going to fail that class. They don't and every semester some of them do… some of them, they just suck it up and they act like adults like, "Okay, I don't want to do this, but I have to." Others are like, "I'll just make up an excuse for her and she'll let me slide." Which some do, and some don't, some do, and some don't. I'm kind of half and half. Some days I'm like, "No," I get tired of it. Other times some of the things that I focus on in there that I know they come out with [...] It's not necessarily the reading or the note-taking that

> they end up getting a handle on, it's a little bit more of like adult skills. Do you know what I mean?

With specific regard to iSTART training Instructor 3 felt that students “didn't think they had to do it…” Instructor 3 felt there was a need to be more forceful with students in order to counteract their resistance to completing the iSTART training. After the first check-in (after the second practice assignment was due), Instructor 3 realized that a considerable number of students were still lagging behind with regard to completing the iSTART tutorial and practice assignments. Reflecting on the situation, Instructor 3’s reasoned

> I don't think they really understood till the end that if they didn't do it they would fail. I really don't. Even though you said it, even though I said it, "This is an assignment," I should have said from the beginning [...] I should have just threatened them in the very beginning and said, "You might as well start now because if you don't finish this you don't pass." I didn't say it like that until the end, when I kind of was forced to.

Summary of Qualitative Findings

The instructor interviews revealed that the three instructors shared varying perspectives with regard to the primary purpose of the first-year experience course. Instructor 1 and Instructor 2 communicated that the primary purpose of the course was as help learners develop requisite knowledge about the university, whereas Instructor 3 viewed the primary purpose of the course as helping learners develop requisite academic skills. In addition to these differences, the instructional emphasis of the three instructors varied substantially. While the instructional emphasis of Instructor 2 and Instructor 3 aligned with the stated course purposes, the instructional focus of Instructor 1 centered primarily on issues pertaining to diversity. Instructor 1 devoted a considerable amount of course time to exploring the themes of the common reader, particularly with regard to diversity, social justice, and the impact of politics and culture on self-identity. Since Instructor 3 perceived the course purpose differently than Instructor 1 and Instructor 2, and Instructor 1 had a different instructional focus than Instructor 2 and Instructor 3, it is likely that learners in the respective course sections had different perspectives about the purpose and learning objectives of the first-year experience course.

As a result of the differences in instructors' perceptions of the course purpose and their instructional emphases, learners probably maintained variant views regarding the appropriateness of iSTART as a part of the course curriculum. For instance, Instructor 1 and Instructor 3 experienced resistance from their learners with regard to engaging with iSTART. Instructor 1's emphasis on issues pertaining to diversity did not foster the inclusion of iSTART. Conversely, the inclusion of iSTART in Instructor 3's course sections, with their strong emphasis on academic skill development for students who are underprepared for college, may have further stigmatized learners who were denied immediate access to the main campus (Brown & Lee, 2007). Unlike Instructor 1 and Instructor 3, Instructor 2 did not perceive any resistance with regard to iSTART. Instructor 3 maintained a broad view of the purpose of the first-year course and a balanced emphasis on the course topics. In addition, Instructor 3 supplemented the course focus by reinforcing academic mindsets to support student achievement.

The instructor interviews also revealed that instructors experienced varying levels of resistance from learners regarding the completion of course homework assignments. The students in Instructor 1's sections did not want to complete out-of-class assignments but 90% of students in the two sections of Instructor 2 completed course assignments on time. Similar to Instructor 1, Instructor 3's students resisted completing assignments. These patterns of learners' resistance (responsiveness in the case of Instructor 2) were also reflected in learners' completion of iSTART tasks.

The messages instructors communicated to learners influenced the level of resistance instructors perceived as well as the academic behaviors learners demonstrated within the course, including the completion of iSTART tasks. As stated above, Instructor 1 and Instructor 3 experienced a high degree of learner resistance to completing coursework. Both instructors made compromises on academic standards. Consequently, some learners took advantage of perceived loopholes to avoid completing their work. In contrast, Instructor 2 maintained an organized system to track learners' progress on assigned course tasks. In addition, Instructor 2 communicated clear and consistent course standards on expectations regarding the completion of coursework. Finally, Instructor 3 strived to promote learners interest in the coursework by making it relevant with regard to their academic needs and personal interests. As a result of these efforts, most learners in Instructor 2's course sections completed their coursework in a timely manner.

Chapter 6

DISCUSSION

Beginning college learners’ intelligence (Dweck, 2006; Wood & Bandura, 1989) and motivational beliefs (Bernacki et al., 2012; Harackiewicz et al., 2002; Zimmerman & Kitsantis, 2007) influence their academic behaviors and achievement outcomes. The first purpose of this study was to examine whether growth mindsets (versus fixed mindsets) are related to beginning college learners’ reading comprehension strategy use and achievement outcomes and whether this relation is mediated through their motivational beliefs. The second purpose of this study was to ascertain if a growth mindset intervention led to adopting beneficial intelligence and motivational beliefs, increasing use of deep-level reading comprehension strategies, and improving academic performance among learners.

Intelligence Theories, Motivational Beliefs, and Reading Comprehension Strategy Use

The first research question was as follows: Do motivational beliefs mediate the relationship between implicit theories of intelligence and reading comprehension strategy use? Five hypotheses tested whether implicit beliefs about intelligence (Time 1) influenced reading comprehension strategy use (Time 2) by way of the four achievement goals and reading efficacy beliefs (Time 1). Three models were tested for each hypothesis.

Of the fifteen models tested, only one model revealed significant results. Controlling for treatment condition, mastery-approach goals (Time 1) mediated the relationship between incremental beliefs (Time 1) and reading comprehension strategy use (Time 2). These results suggest that the relationship between incremental beliefs (Time 1) and reading comprehension strategy use (Time 2) was explained by mastery-approach goals (Time 2), particularly because the direct relationship between incremental beliefs (Time 1) and reading comprehension strategy use (Time 2) was non-significant.

The results of this study are not consistent with Dweck's (1999) theoretical model. Dweck (1999) posited that intelligence beliefs predict achievement goal orientation and influence efficacy beliefs, which in turn direct learners' use of strategies. First, for the majority of the models, there were no significant results. That is, there was no evidence that performance goals, mastery-avoidance goals, and reading self-efficacy mediated the relationship between incremental beliefs and reading strategy use.

Second, the one model that had significant results revealed findings that were not aligned to predictions based on Dweck's theoretical model. According to Dweck (1999), adoption of mastery-oriented goals mediated the positive relationship between incremental beliefs and reading strategy use. In other words, when learners have incremental beliefs, they adopt mastery-oriented goals, which in turn direct learners to use strategies that increase their intellectual growth in terms of increasing understanding and mastery.

Other research has revealed similar results as the present study. Dupeyrat & Mariné's (2005) found that mastery-oriented goals mediated the relationship between implicit beliefs about intelligence, as measured by entity beliefs, and strategy use. Their path analyses also revealed no evidence that performance-oriented goals mediated the relationship between implicit beliefs about intelligence and strategy use.

Although the results of the present study indicated there was a mediation effect, the nature of the mediation was unexpected. Rather than directing learners to use strategic knowledge, mastery-approach goals had a suppression effect on the direct relationship between Time 1 incremental beliefs and Time 2 reading comprehension strategy use. The suppression effect of mastery-approach goals is evident in the examination of the indirect and direct relationships between incremental beliefs (Time 1) and reading comprehension strategy use (Time 2). After including mastery-approach goals as the mediator, the positive relationship between incremental beliefs (Time 1) and reading comprehension strategy use (Time 2) was reversed in terms of the direction of the relationship. This meant that learners' use of reading comprehension strategies decreased as a result of holding incremental beliefs.

One possible explanation for the observed suppression effect of mastery-approach goals is chance. Since the suppression effect was only observed in one model, and the amount of variance explained by the total effect and the *a* and *b* paths is small, it is possible that the results are due purely to chance.

A second explanation for the observed suppression effect of mastery-approach goals is that learners in this research may have reported that they maintained mastery-approach goals, when in fact their academic behaviors were directed by other competency pursuits. Dompnier, Darnon and Butera (2009) suggested that one reason results regarding mastery-approach goals are often inconsistent is that learners may convey that they maintain mastery-approach goals because they perceive that these goals are socially acceptable rather than because they believe that the goals are useful for achievement.

A third explanation that speaks to all results for the first hypothesis is that learners' achievement goals were not measured at the appropriate level of analysis. Evidence from Richey, Bernacki, Belenky, and Nokes-Malach (2017) suggests that achievement goals measured at the classroom level are not reflective of learners' behaviors or achievement on specific tasks. Instead classroom-level goals are related to classroom-level behaviors and achievement, and goals measured at the task-level are related to specific task behaviors and achievement. Richey et al.'s (2017) findings are particularly relevant for this research since iSTART tasks differed substantially from the other tasks in the first-year course. For the most part, first-year instructors taught weekly lessons or facilitated group discussions, but for iSTART, learners were required to independently engage in self-paced learning activities with an automated tutor. This study measured achievement goals in terms of the first-year course. Given the differences between the first-year course and the iSTART activities, it is possible that the goals learners adopted for iSTART differed from the goals they reported for the first-year course.

Motivational Beliefs, Reading Comprehension Strategy Use, and Reading Comprehension

The second research question asked whether reading comprehension strategy use mediated the relationship between motivational beliefs and achievement outcomes. The first five hypotheses tested whether the four achievement goals and reading efficacy beliefs (Time 1) influenced reading comprehension (Time 2) by way of reading comprehension strategy use (Time 2). Three models were tested for each hypothesis.

The analyses revealed null results for all mediation models. These results are not consisted with Dweck's theory (1999). Dweck (1999) posited that the orientation of learners' achievement goals and the strength of their efficacy beliefs direct the patterns of strategic behaviors learners employ when presented with academic tasks. Furthermore, the quality of the strategic behaviors learners employ influences their achievement outcomes.

Other research supports Dweck's theory (1999). For instance, Phan (2009b) found evidence that self-efficacy beliefs and mastery goals indirectly influenced learners' achievement outcomes by way of strategy use. The researcher conducted two studies that included examinations of the relations among achievement goals, study strategies, and academic achievement as well as the relations among self-efficacy beliefs, study strategies, and academic achievement. The results showed that deep-processing strategies mediated the relationships between mastery goals and achievement and between self-efficacy beliefs and achievement goals. The researcher did not examine mastery-avoidance goals.

Ranellucci (2013) also found evidence of mediational pathways between certain achievement goals and learners' achievement by way of strategy use. Specifically, the researcher examined the relations among achievement goals, use of deep-processing strategies, and achievement, as measured by conceptual change. The researcher found that mastery goals had an indirect positive effect on achievement by way of strategy use. In addition, performance-avoidance goals had a negative indirect effect on achievement by way of strategy use. Mastery-avoidance goals and self-efficacy beliefs were not examined in the study.

Other research, however, has found similar findings to this study. For instance, in addition to the findings discussed above, Phan (2009b) also found no evidence that strategy use mediated the relationships between performance-approach goals and achievement and between performance-avoidance goals and achievement. Likewise, Ranellucci (2013) found no evidence that either deep- or shallow-processing strategies mediated the relationship between performance-approach goals and learners' achievement. Elliot et al. (1999) also found similar findings. The researchers conducted two studies that examined whether strategic processes mediated the relationships between achievement goals and reading comprehension among college students. The researchers did not examine mastery-avoidance goals or reading efficacy beliefs. Similar to this research, there was no evidence that comprehension strategy use mediated any of the relationships the three achievement goals had with reading comprehension scores.

There is some consensus within the literature regarding the nature of the relationships between achievement goals, strategy use, and achievement. Specifically, the literature suggests that learners' strategy use does not mediate the relationship between performance-approach goals and achievement. In addition, with the exception of Ranellucci (2013), other literature indicates that learners' strategy use also does not mediate the relationship between performance-avoidance goals and achievement. The mediational role of learners' strategy use between (1) mastery-approach goals and achievement, (2) mastery-avoidance goals and achievement, and (3) self-efficacy beliefs and achievement is still unclear.

While Phan (2009b) and Ranellucci (2013) found evidence of an indirect effect of mastery-approach goals on achievement by way of strategy use, the results of this research and Elliot et al. (1999) indicate there is no indirect effect. As discussed previously, the present study's findings may be due to learners' expressing maintenance of these goals because they perceive they are socially acceptable rather than because they actually pursue these goals (Dompnier, et al., 2009). If the goals that learners report do not reflect the goals they enact while working on particular tasks, then it is likely that the hypothesized relationships will not be observed.

As discussed previously, a second explanation for the present study's results is that achievement goals should have been measured at the task level instead of at the class level (Richey et al., 2017). It is possible that the goals learners expressed on the achievement goal surveys do not reflect the competency pursuits they held for iSTART tasks. If the goals learners expressed on the surveys did not align with the goals they enacted while working on iSTART, it would explain why the anticipated patterns regarding subsequent strategy use and achievement were not realized.

Another explanation for the null findings is that the study had insufficient power to reject the null hypotheses. Insufficient power reduces the likelihood that inferential tests will detect existing differences within the data (Huberty & Olejnik, 2006; Stevens, 2002).

Motivational Beliefs, Reading Comprehension Strategy Use, and Reading Skill

Five additional hypotheses (hypotheses 6 through 10) tested whether the four achievement goals and reading efficacy beliefs (Time 1) influenced reading skill (Time 2) by way of reading comprehension strategy use (Time 2). Three models were tested for each hypothesis.

Contrary to Dweck's theory (1999), the results of this study did not provide evidence that reading comprehension strategy use mediated the influence that any of the four achievement goals and reading efficacy beliefs had on reading skill scores. One explanation for the null results is that the measures of reading strategy use and reading skills were assessing reading under different conditions. In this study, iSTART taught students to use a reading strategy that required spending time delving into the text. Specifically, students learned to self-explain text. In fact, self-explanation of text was used to measure reading strategy use. In contrast, the measure of reading skill was based on a task that provided learners 20 minutes to read several texts and answer a series of multiple- choice questions. The nature of the posttest reading comprehension skill assessment was not conducive to students delving deeply into the text nor conducive to students spending time engaging in self-explanations of the text.

Effects of the Growth-Mindset Intervention

The third research question was as follows: Does a growth-mindset intervention influence learners' endorsement of intelligence and motivational beliefs, use of reading comprehension strategies, and academic outcomes? The results for two of the three MANCOVAs were significant. The results for one of the MANCOVA and related discriminant descriptive analysis revealed that compared to the learners in control condition, learners in the growth-mindset treatment group had higher performance-avoidance goals, lower mastery-approach goals, and lower total reading comprehension scores. The findings from the second MANCOVA and related discriminant descriptive analysis showed that learners in the growth-mindset treatment group had higher performance-avoidance goals, lower mastery-approach goals, and lower textbase reading comprehension, compared to learners in the control treatment group. Interestingly, both set of analyses indicated that the treatment and control groups were not different in terms of incremental beliefs at Time 2, controlling for Time 1.

Some previous research showed that teaching learners a growth-mindset led to significant positive changes in incremental beliefs about intelligence and achievement (Blackwell et al., 2007; Paunesku et al., 2015). Over the course of eight weeks, Blackwell et al. (2007) taught low-achieving seventh grade learners information about the brain, study skills and a lesson on avoiding stereotyping. Learners assigned to the experimental condition also received four lessons on the growth-mindset. The researchers found that the growth-mindset intervention led to positive changes in learners' incremental beliefs and a positive shift in the trajectory of their math performances. In contrast, the intelligence beliefs of learners in the control group remained stable and they experienced a continued decline in math performance.

Paunesku et al. (2015) randomly assigned low-achieving high school students to one of four conditions: growth mindset, sense of purpose, growth mindset and sense of purpose, or control. The authors found that learners assigned to the growth-mindset condition had a significant positive increase in incremental beliefs, whereas learners in the other treatment conditions did not. In addition, learners who participated in the growth-mindset intervention earned higher grades, compared to learners in the control group condition.

Hattie and Donoghue (2016) argued that encouraging the adoption of a growth mindset among learners is difficult. In their synthesis of 228 meta-analyses, the authors found that interventions aimed at teaching a growth-mindset yielded small effects (d = 0.19) across 85 studies. The author suggested that the focus on high achievement, ability grouping, and social comparisons, which are typically found in schools, may undermine efforts to sway learners to endorse incremental beliefs. For example, in the present study, some of the participants were directed to the Associate in Arts Program because their high-school background indicated they did not have sufficient skills for academic success in a traditional four-year program. This form of ability grouping may undermine the effects of a growth mindset intervention.

In addition, a recent meta-analysis revealed that the effectiveness of growth-mindset interventions may be overstated (Sisk, Burgoyne, Sun, Butler & Macnamara, 2018). In an examination of the effect sizes of 43 growth-mindset intervention studies, the researchers found that in the majority of cases (i.e., 37) the growth-mindset intervention did not lead to significant differences in achievement among the treatment and control group participants. Further examination of moderating effects showed that with regard to age, growth-mindset interventions did not improve academic achievement for adolescents or adults when compared to their counterparts assigned to control conditions. Finally, the meta-analyses revealed one perplexing finding, which was that the effect of the growth-mindset intervention was significant when the growth-mindset intervention manipulation check failed or if a manipulation check was not used. However, if a manipulation check was used and the manipulation check was successful, then the growth-mindset intervention was not effective in terms of increasing achievement for those assigned to the treatment condition.

The meta-analyses of Sisk et al. (2018) and the synthesis of Hattie and Donoghue (2016) illuminated an important finding that is applicable to the present study. In the present study, the fidelity of the growth-mindset intervention indicated that the growth-mindset intervention was successful in terms of teaching the growth mindset. The evidence also showed that learners assigned to the growth-mindset intervention retained an awareness of the ideas and concepts they learned throughout the duration of the study. Specifically, the results showed that compared to learners in the control group, learners assigned to the growth-mindset intervention group communicated more growth-mindset oriented ideas and concepts in the advice they provided to a struggling high-school student and to a peer who was struggling academically and contemplating dropping out of college. These data were collected immediately after the administration of the growth-mindset intervention and during the final phase of data collection, respectively. While learners who were exposed to the growth-mindset treatment condition expressed significantly more growth-mindset oriented ideas and concepts in their written responses than learners in the control group, they did not maintain higher incremental beliefs compared to learners in the control group. Furthermore, in comparison to the control group, they did not experience the anticipated positive changes in their pattern of achievement goal adoption, strategy use, or reading comprehension.

In fact, the results that were statistically significant revealed patterns of motivational beliefs and achievement outcomes that were in the opposite direction of the predictions. Compared to the learners in control condition, learners in the growth-mindset treatment group had higher performance-avoidance goals, lower mastery-approach goals, and lower total reading comprehension scores. The learners in the growth-mindset treatment group also had higher performance-avoidance goals, lower mastery-approach goals, and lower textbase reading comprehension, compared to learners in the control treatment group.

One explanation for the lack of consistency between the findings of this research and the anticipated results is due to the complexity of the interplay among individual differences among students, dissimilar instructional practices, variations in course designs, and institutional policies (Hattie, 2015). In a synthesis of over 1200 meta-analyses, comprised of over 65,000 studies, Hattie (2015) found that student differences accounted for about 50% of the variance in learning outcomes and instructor-controlled differences accounted for another 20% to 25% of the variance. Student differences include, but are not limited to, factors, such as prior achievement, responses to academic tasks and situations, and motivation for learning. Instructor differences include the methods of teaching and instructor attributes, such as efficacy and expectations.

Yeager and Walton (2011) acknowledged that the complexity of learning environments makes it difficult to replicate mindset interventions. The authors recommended that mindset interventions should be contextualized to meet the needs of specific groups of learners and local conditions. In this research, however, the salience of contextual complexities came to light only when they were sought out to explain null or unanticipated results. Consequently, controlling for these contextual features was not a prior or practical consideration for this research. Kaplan and Patrick (2016) also acknowledged the complexity of learning environments. In contrast to Yeager and Walton (2011), however, rather than focus on controlling or intervening on learner differences, Kaplan and Patrick (2016) suggested, recognizing that the dynamic nature of complex learning environments can cultivate motivational patterns that are atypical to theorized motivational models. These atypical patterns may provide insights in and of themselves for advancing our understanding of students' motivation for learning. Accordingly, while the results of the two MANCOVAs for this research were unanticipated, they do draw attention to the complexity of environmental factors, as well as the interdependence of these factors with learners' motivational beliefs, strategy use and achievement outcomes.

Learners' Experiences within the First-Year Seminar

One explanation that came to light with regard to the lack of consistency between the findings of this research and those reported in other literature is related to the instructional context of the participants. Specifically, the instructional practices employed by two of the instructors in this research may have impacted the effects of the growth-mindset intervention for many of the learners assigned to the growth-mindset treatment condition.

The instructional practices of these instructors are relevant to explaining the findings of this research question because 81% of the learners assigned to the growth-mindset treatment condition were enrolled in their course sections (see Table 6). Instructor 1 and Instructor 3 adopted instructional practices that compromised the academic standards of their course sections, which may have prompted learners to forgo completing course assignments, including iSTART tasks. In addition, these instructional practices also contributed to learners' resistance to and persistence in completing the research tasks and iSTART training. If learners resisted completing the iSTART training and tasks, then they may not have sufficient time to learn and practice iSTART strategies with the automated tutor as well as in other courses. Differences in learners' completion rate of iSTART training tasks would then impact learners' strategy use and comprehension scores on the reading tasks for this study.

Instructor 1's and Instructor 3's instructional practices did not foster the development of mastery-approach achievement goals among learners assigned to the growth-mindset treatment group. For instance, Instructor 1 did not enforce accountability for completing coursework. In addition, he or she encouraged unprepared learners to participate in group discussions by regurgitating the ideas and themes of other learners. The instructor communicated that his or her attempt to improve class participation was not effective and that over time, additional learners adopted the habit of not completing assigned readings. In addition to hindering the adoption of mastery-approach goals, Instructor 1's practices may have led to the adoption of performance-avoidance goals because learners were conditioned to hide their incompetence regarding course content by paraphrasing others' ideas (Wirthwein et al., 2013).

Similar to Instructor 1, Instructor 3's instructional practices may have undermined the adoption of mastery-approach oriented achievement goals. Instructor 3 did not convey a consistent message regarding the necessity of completing coursework. Learners were given leeway based upon the instructor's feelings of the learner. Consequently, learners regularly tested boundaries by first determining whether they "really" had to complete assigned academic tasks. The inconsistent requirements regarding learners' obligations to complete assigned tasks did not support the development of mastery-approach goals among learners. Rather than encourage meaningful learning, skill development, or improved understanding, these practices fostered resistance to learning and work-avoidance goals (Meece, Anderman, & Anderman, 2006).

Instructor 1's and Instructor 3's instructional practices impacted data collection for this research. Specifically, the missing data analysis found that most of the missing data for this research was attributed to learners assigned to the growth-mindset intervention group, and that most were enrolled in the course sections taught by these two instructors. In addition, with regard to independently practicing the use of iSTART strategies in other courses, there was a significant difference in learners' practice by course instructor. Students in Instructor 2's course sections reported using significantly more strategies in other courses than students taught by the other two instructors (see Figure 1).

In contrast to the other instructors, Instructor 2 conveyed consistent messages regarding the academic standards of the course and carefully monitored students' progress by using the university's learning management systems. Consequently, Instructor 2 experienced a high assignment completion rate among learners in his or her course sections. Pascarella et al. (2008) found evidence that instructors' organizational and instructional practices can have a positive impact on learners' academic skill development and commitment to persistence at their academic institution. The endorsement of academic skill development and commitment to persistence are features of mastery-oriented instructional practices and may explain the adoption of mastery-approach oriented goals among learners in Instructor 2's course sections, particularly those who were assigned to the control group treatment condition (Meece et al., 2006). Figures 4 and 5 show that the control group had higher mastery-approach goals than the growth-mindset treatment group. Seventy-four percent of the learners in Instructor 2's course sections were assigned to the control treatment group. In addition, they comprised about 50% of the total control group membership (see Table 6).

Another possibility brought to light by the qualitative findings of this research is that differences in instructors' perceptions of the first-year seminar's purpose and curriculum influenced learners' engagement with academic tasks, including iSTART training and practice. Instructors 1 and 2 viewed helping learners develop requisite knowledge about the university as the primary purpose of the course. In terms of course emphasis, however, Instructor 1 emphasized themes related to the common reader, such as diversity, social justice, and self-identity while Instructor 2 maintained a broader focus that was aligned with the university's learning outcomes for the course. In contrast, Instructor 3 also maintained a broad instructional focus that was aligned with the university's learning objectives; however, he or she perceived that the primary purpose of the course was to help beginning college learners in the AA Program develop requisite academic skills.

Students who spent most of their course time focused on issues pertaining to diversity, social justice, and self-identity may have perceived that the requirement to complete the iSTART activities did not fit with the first-year course's purpose and learning objectives. These perceptions may also have been exacerbated by the fact the instructor did not communicate enthusiasm for teaching academic skills. Supporting evidence from research with younger learners suggests that when teachers communicate affective messages about tasks, they are subsequently adopted by learners (Patrick et al., 2001). Furthermore, the affective messages instructors communicate about course content inform learners' understanding of what counts as competence and achievement within the course (Britt, Rouet, & Durik, 2018). Britt et al. (2018) suggested that learners are likely to be more attentive to tasks that reflect the elements that are valued and counted as achievement within learning environments.

Learners' Experiences in the University's AA Program

Extending beyond learners' immediate experiences within the first-year course, a third possibility is that learners' broader experiences in the university's AA Program influenced their engagement with academic tasks, including iSTART training and practice. Specifically, institutional policies and practices with regard to admissions and the distribution of resources may have communicated to learners that their social identity as students enrolled in the AA Program was devalued in comparison to students attending the university's main campus.

For instance, some of the learners chose to attend the AA Program, but other learners were offered admissions to the AA Program instead of admissions to a traditional four-year bachelor's program on the main campus. They were informed that the AA Program would better serve their academic needs. In the spring of 2017, Veness (2017) conducted a public scholarship project to better understand students in the AA Program as well as to describe the experiences of the students, especially as compared to the students who attended the main campus. Veness (2017) found that 58% of the respondents in the AA Program at Campus 1 indicated that their campus location was their first choice. In addition, only 40% of the respondents enrolled at the second site indicated that Campus 2 was their first choice. In contrast, 96% of the respondents enrolled in the four-year program said the main campus was their first choice.

Evidence from Veness (2017) suggests that some students in the AA Program felt stigmatized by the institution. Thirty-four percent of the respondents from Campus 1 and 40% of the respondents from Campus 2 conveyed that they did not feel like a valued part of the university's community while only 15% of the respondents from the main campus felt they were not a valued part of the university. In addition, 45% of the respondents from Campus 1 and 58% of the respondents from Campus 2 conveyed they did not enjoy spending time at their campus location while only 8% of the respondents from the main campus responded similarly.

Their lack of belonging and perception of being devalued are due to the fact that the learners in the AA Program may be aware that the university does not provide the same resources that students on the main campus are given. For instance, one of the sites for the AA Program did not participate in this study because the AA Program was not provided access to the computer lab during course meeting times. Given that students are made aware of the university's resources on the main campus as a part of the first-year course, it is likely they were aware that their experiences in the university's AA Program were disparate from the experiences of learners enrolled at the main campus.

Steele et al. (2002) suggests that when individuals are aware that a group with which they identify is devalued by those outside the group, they become susceptible to stereotype threat. Furthermore, Aronson et al. (2002) asserts that "the mind-set imposed by stereotype threat may be strong enough to overwhelm an individual's own implicit beliefs about intelligence" (p. 116). The combination of not being admitted to the four-year program and the awareness of differential treatment by the university may have impacted the growth-mindset intervention and learners' adoption of incremental beliefs (Sisk et al., 2018; Yeager & Walton, 2011).

Limitations

The current findings were limited by several factors. First, there was a significant loss of power associated with this study. One reason for the low power was that the researcher was not able to recruit participants from one of the original sites because the students did not have access to a computer lab. A second reason was the result of the high degree of missing data, particularly among participants in the growth-mindset treatment condition. It is likely that the small effect sizes and some of the null inferential results in this report were due to a lack of power (Huberty & Olejnik, 2006; Stevens, 2002).

Second, the student population sampled is not representative of all beginning college learners, so these results are less generalizable. The participants in this study were students in an Associates in Arts program tied to a traditional 4-year college. Some of the participants had self-selected to attend the AA Program, while others had enrolled in the program because they were not offered admission to the traditional 4-year college program. These students were told that the Associate in Arts program was a better fit for them because it would help them develop academic strengths and skills to complete a rigorous academic program in a supportive small-campus environment. Moreover, the AA Program is only for in-state residents. Consequently, the participants in this study may not be representative of all beginning college learners at 4-year or 2-year institutions and programs. Second, the student population sampled is not representative of all beginning college learners, so these results are less generalizable.

Recommendations for Future Research

The findings of this research indicate that there is much more to learn about the patterns of relations among implicit beliefs about intelligence, achievement goals, strategic processing, and learner outcomes, particularly for college learners. First, the findings of this research indicate that there is a larger degree of variability in the ways that intelligence and motivational beliefs interact to influence strategic behaviors and learner outcomes. In addition, learners in the growth-mindset group earned lower textbase comprehension and total comprehension scores than learners in the control group. Furthermore, learners in the growth-mindset condition did not evidence the positive increase in incremental beliefs that was expected. Rather, they maintained equivalent incremental beliefs as learners in the control group.

Much of the research regarding Dweck's (1999) theory has focused on the relations and roles of intelligence and motivational beliefs with regard to strategy use and achievement. Several recommendations for future research should be considered.

With regard to stigmatized college learners, future studies on the relations of implicit beliefs about intelligence to achievement goals, strategic processing, and learner outcomes should also attend to learners' experiences within the learning environments at both the course and institutional levels. Attention should also be given to exploring how specific threats operate at both individual and group levels. As suggested by Shapiro and Neuberg (2007) and evidenced in this research, threats to social identity can be derived from stigmatized perceptions about the self or one's social group identity.

In addition, as evidenced in this research and discussed in Yeager and Dweck (2012), there is a need to explore the efficacy of growth-mindset interventions in terms of their transferability to varying contexts. Given that growth-mindset interventions focus on changing learners' self-beliefs about intelligence nested within dynamic complex learning contexts, future researchers should consider the work of Kaplan and Patrick (2016). Specifically, rather than attempt to control for the variances in individual differences and learning contexts, researchers can capitalize on particular features of learning environments by collaborating with stakeholders to provide targeted interventions to reach specific subsets of individuals. Once evaluated, interventions can be recalibrated to address emergent needs. This approach to motivational interventions may help to expand our understanding of the unique motivational and achievement patterns that can immerge in learning contexts.

Also, research is still needed to improve our understanding of the antecedents and causal effects of mastery-avoidance goals. To date, very little research exists on mastery-approach goals. Baranik et al. (2010) has demonstrated that mastery-avoidance goals are a distinct construct that may prompt a unique pattern of academic behavior in comparison to mastery-approach goals. Consequently, one suggestion is for future achievement goal research to include these goals.

Findings of this research also suggest that there is a need to explore alternate methods for measuring achievement goals at the task-level. Evidence suggests that for this research, the achievement goals learners maintained for the first-year course may not have aligned with the goals they pursued while engaging with iSTART training and practice materials. Alternate methods of measuring task-level achievement goals may help improve the delivery of interventions aimed to foster achievement goals that support learning. Prior research has found that achievement goals measured at the task-level are better predictors of task behaviors and performances (Richey, 2017).

Other opportunities for future research reside in improving the causal inference methods used to test Dweck (1999), specifically the relations among implicit beliefs about intelligence, achievement goals, strategic processing, and learner outcomes. While aspects of this research examined some causal relationships, there is a need to examine the full causal model in a manner that sequentially tests the theory associated with the predictors and mediating variables (MacKinnon et al., 2007).

Conclusions

This research began with this question: Is there a way to prevent the downward academic spiral of beginning college learners who have low comprehension skills and maintain beliefs that support the notion that intelligence is fixed? The findings of this research suggest that the answer needs to address more than learners' intelligence beliefs. Rather, it also needs to attend to learners' perceptions of their learning experiences, which may mean helping learners understand the necessity of the courses they are required to take and the tasks they are asked to complete. It may also mean that there is a need to examine the quality of college-level instructional practices.

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Appendix A

INTERACTIVE STRATEGY TRAINING FOR ACTIVE READING AND THINKING (iSTART)

iSTART reading comprehension training teaches learners how to utilize the technique of self-explanation, as well as five reading comprehension strategies to improve their comprehension of texts (McNamara et al., 2007). iSTART training is self-paced and explicitly presented in the following eight modules: (1) the overview, (2) monitoring, (3) paraphrasing, (4) prediction, (5) elaboration, (6) bridging, (7) summary, and (8) demonstration.

To begin iSTART training, learners log in and click first on the *Training* tab (see Figure 6)and then on the *Overview* icon (see Figure 7). In the *Overview* section, learners are greeted by Mr. Evans, an animated pedagogical agent who guides them through the eight iSTART training modules. Mr. Evans begins the training by asking learners, "Have you ever read through half a chapter [of a science textbook] and realized you didn't understand a word of it?" He then informs learners that in the iSTART training, they will learn a technique and several strategies to help improve their comprehension of texts.

Mr. Evans introduces the technique of self-explaining as a process whereby readers explain the text in their own words, ask themselves questions about the text, and incorporate their answers to these questions into their explanations of the text. He informs learners that together, these processes help improve readers' comprehension of texts as they read.

After introducing the self-explaining technique, Mr. Evans guides learners through a brief demonstration of using it to improve comprehension of a sentence from a science text. Finally, Mr. Evans introduces the five strategies taught in the iSTART training lessons:

1. Comprehension monitoring: Continuously checking for understanding of what you are reading.
2. Prediction: Thinking ahead about what the text might cover next.
3. Paraphrasing: Rewriting or explaining the text in your own words.
4. Elaboration: Connecting the text to your knowledge of the world.
5. Bridging: Connecting the current idea to other parts of the text.

When the introduction concludes, learners are instructed to close the window and proceed to the first lesson on comprehension monitoring.

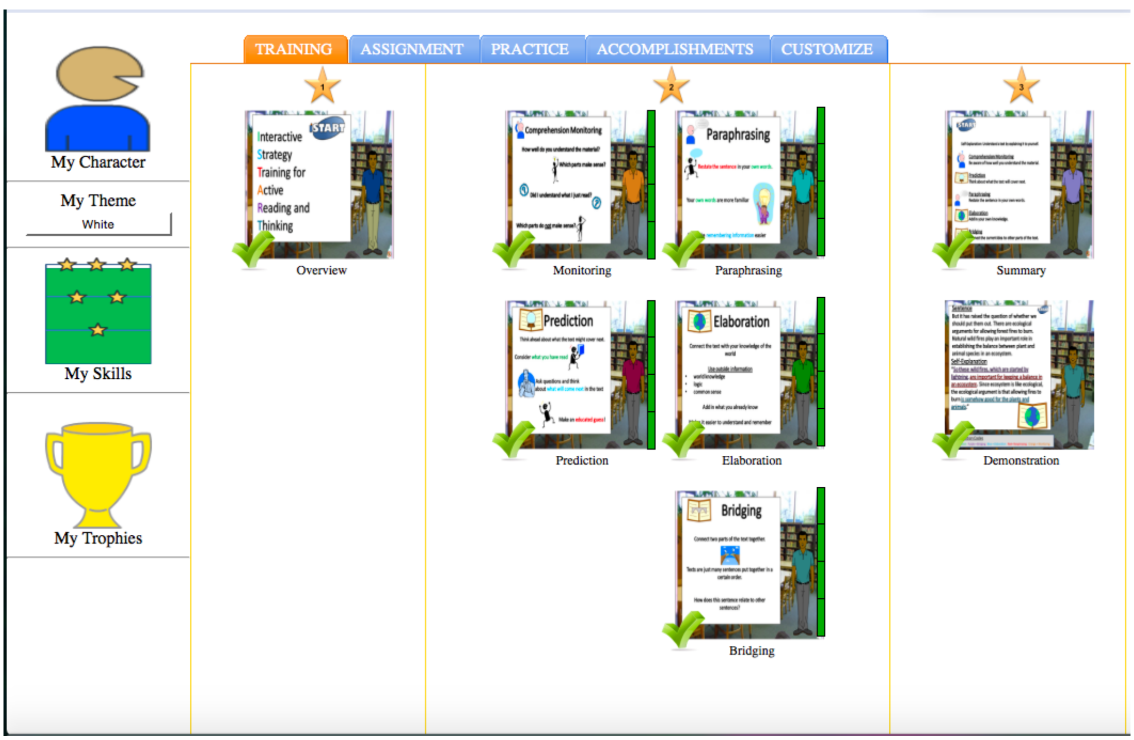

Figure 6. iSTART training page.

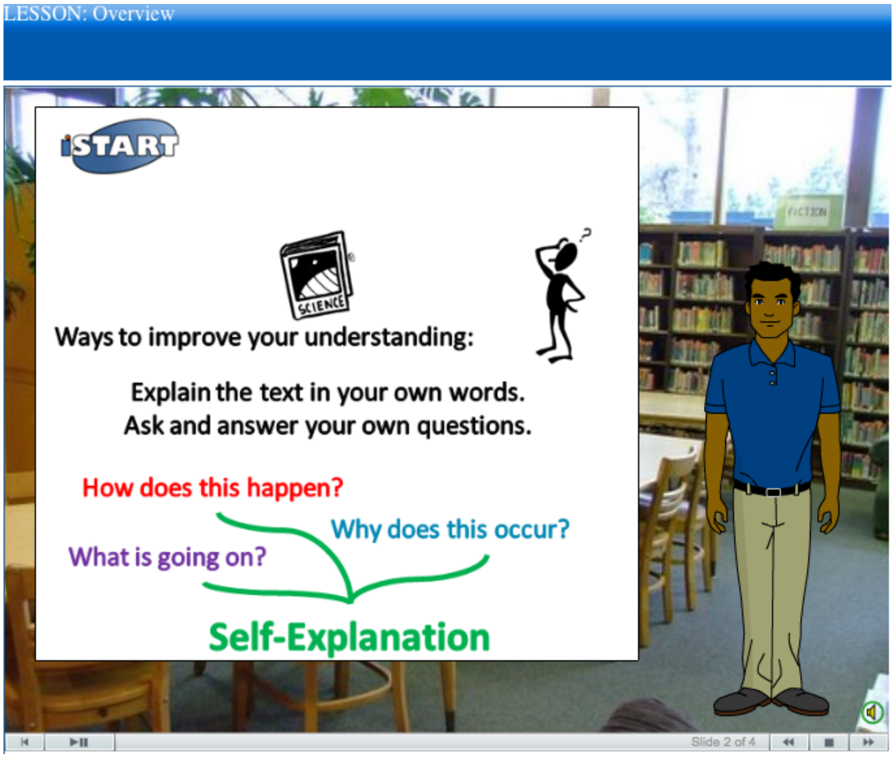

Figure 7. iSTART overview of self-explanation technique.

In the second phase of iSTART training, each comprehension strategy is presented individually in separate modules. In each module, Mr. Evans introduces the respective strategy and describes how it is used to enhance readers' self-explanations of texts and improve their subsequent reading comprehension. Finally, Mr. Evans provides several examples to demonstrate the use of the strategy with sample texts. Figure 8 includes screenshots of select iSTART training lesson demonstrations of the self-explanation technique, as well as use of the various reading comprehension strategies.

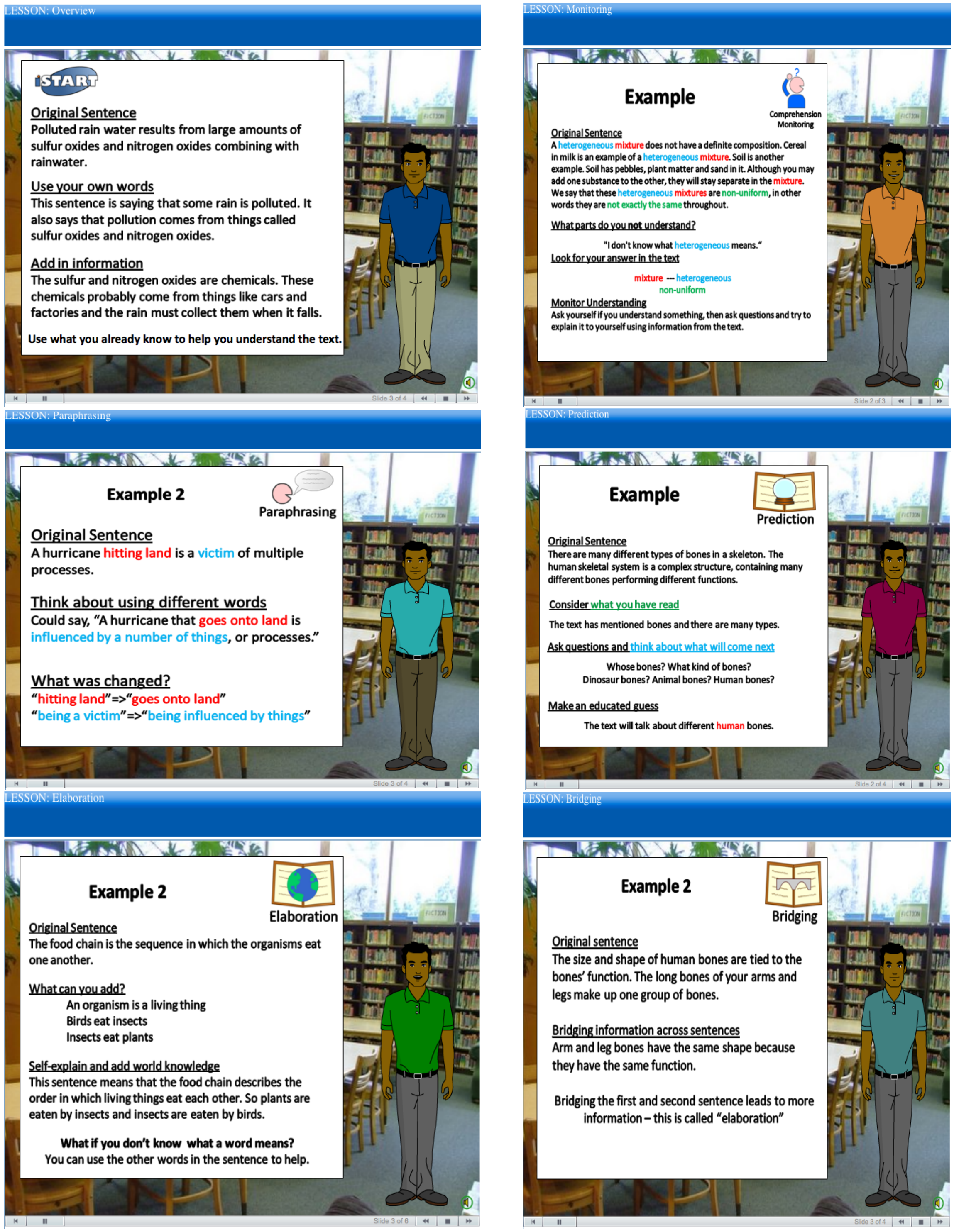

Figure 8. iSTART strategy examples.

The third phase of iSTART training includes the summary and demonstration modules. The summary begins by congratulating learners on completing the initial part of the iSTART training. Mr. Evans, the pedagogical agent, then provides a brief review of the self-explanation technique and the five reading comprehension strategies taught in iSTART. Afterwards, Mr. Evans encourages learners to use self-explaining and the five reading comprehension strategies. He points out that:

- Remembering the names of the strategies or the differences between each of the strategies is less important than remembering how to use the strategies to help improve comprehension.
- Learners should try to use some of the reading strategies all the time.
- Learners have just learned the strategies, so they should keep practicing the strategies and try to improve. As their use of self-explanation improves, they will be surprised how much their comprehension of texts will improve, as well.
- It is worth the time and effort to learn these strategies.

In the demonstration module, Mr. Evans presents a short excerpt of a science text and leads the viewer through several demonstrations of how to apply self-explanation and the five reading comprehension strategies to improve his or her understanding of the text's meaning. Learners are also encouraged to practice self-explaining and to apply more than one reading comprehension strategy at a time (e.g., paraphrasing and bridging, or paraphrasing, elaboration, and bridging). The initial training, including the summary and demonstration modules, takes approximately 40 minutes to complete (see Table 55). After the demonstration module, learners are instructed to close the current window and click on the practice tab to practice using self-explaining and the reading comprehension strategies (see Figure 9).

Table 55

Estimated Time for iSTART Training in Minutes and Seconds

Module	Video Length	Estimated Time for Checkpoint	Estimated Time on Training Module
Introduction	3:00	---	3:00
Comprehension Monitoring	2:35	1:00	3:35
Prediction	2:22	1:35	3:57
Paraphrasing	2:04	1:47	3:51
Elaboration	4:17	2:00	6:17
Bridging	2:40	3:00	5:40
Summary	2:48	---	2:48
Demonstration	7:20	---	10:00
Total Estimated Time			**36:28**

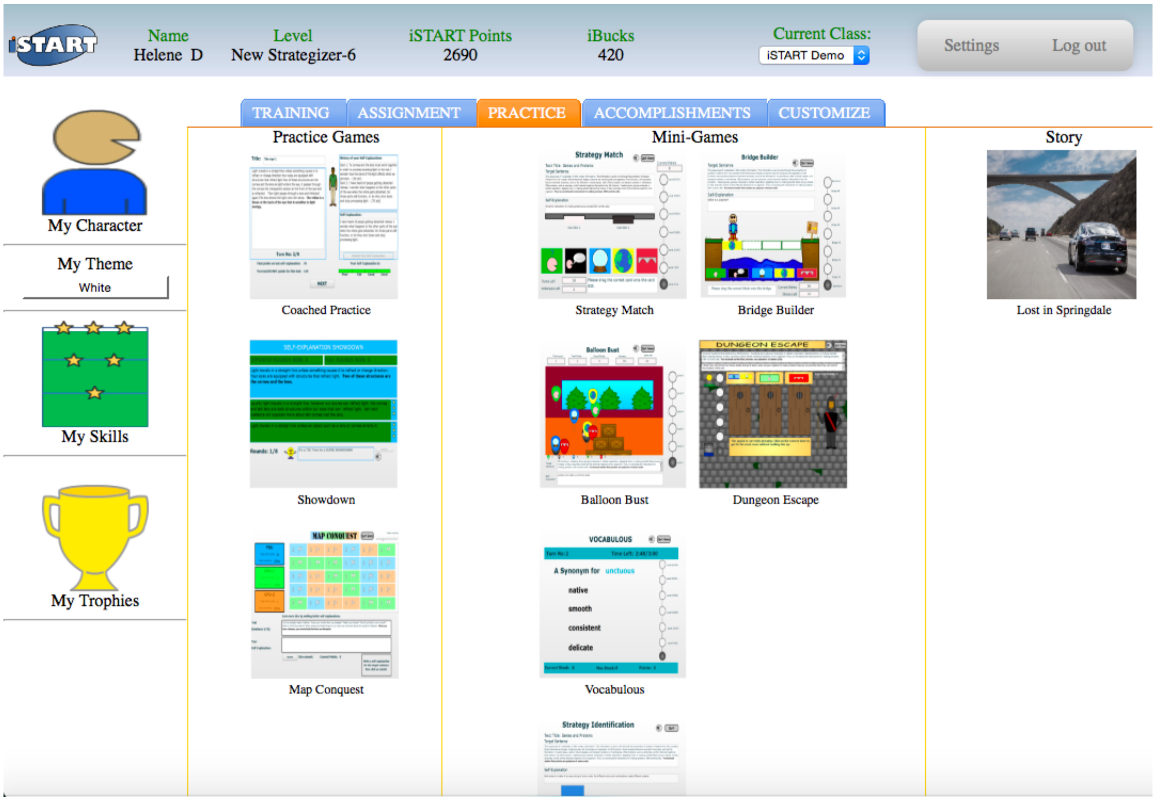

Figure 9. iSTART practice page.

In the present study, in addition to completing the eight initial training modules (overview, comprehension monitoring, paraphrasing, prediction, elaboration, bridging, summary, and demonstration), learners completed four iSTART practice assignments to practice using the self-explanation technique and the five reading comprehension strategies. All practice activities were accessible by clicking on the *Practice* tab at the top of the screen. There are two types of practice activities in iSTART: *Practice Games* and *Mini Games.* Practice games require learners to self-explain a specified target text and last 15 to 20 minutes. Mini games are shorter activities that require learners to identify self-explanation strategies. Mini games typically last ten to 15 minutes. Learners in this study were anticipated to spend about two hours completing all the practice activities. Table 56 provides a detailed breakdown of the estimated times learners spent on each activity.

Learners were assigned four practice games over the course of the iSTART training. The first two assigned practice games included *Coached Practice*. Learners began by clicking on the *Coached Practice* icon in the left-most column entitled *Practice Games.* In *Coached Practice,* learners were instructed to use the self-explanation technique and the five reading comprehension strategies they learned in iSTART training to self-explain selected portions of the texts as they appeared on the screen. For the first assignment, the text was entitled *Learning,* which was an expository text about learning in college. For the second assignment, the text was a science text entitled *Causes and Effects of Mutations*.

The text for both assignments was presented on six screens and the practice activity required learners to generate six self-explanations. After learners typed and submitted each self-explanation, iSTART provided formative feedback regarding the quality of their work using the following rating scale: “0” Poor - The self-explanation lacked relevancy, was too short, or was too similar to the target sentence; “1” Fair - The self-explanation was confined to the target sentence and was most likely a paraphrase; “2” Good - The self-explanation connected ideas from the target sentence with previous ideas in the text, reflecting the use of bridging; and “3” Great - The self-explanation connected ideas from the target sentence with previous ideas in the text as well as learners’ prior knowledge, reflecting the use of bridging and elaboration, respectively. Finally, after receiving formative feedback, learners were asked to identify the strategies they used to generate each self-explanation and highlight the portions of the target text and their typed responses that corroborated their self-report.

The third assigned practice game was *Showdown*. Learners accessed *Showdown* by clicking on its icon in the left-most column entitled *Practice Games.* In *Showdown*, learners were informed that they would compete against another player (an automated agent) to see who composed the best self-explanations of the text as it was presented on the screen. When *Showdown* began, learners were presented with a screen with several horizontal spaces for information pertaining to the activity. The top row had two boxes that displayed the scores for both players. The second row showed the first part of a science text entitled *Innate Behaviors* along with the target sentence to be self-explained. The third row was designated for the automated opponent. The final row provided learners with a space to type their self-explanation responses. When learners submitted their self-explanations of the text, the automated opponent's self-explanation appeared in its designated space. The text, *Innate Behaviors,* was presented on nine screens and learners were required to generate nine self-explanations. iSTART provided formative feedback to the learner and the automated opponent regarding the quality of his or her work after each self-explanation was submitted. iSTART assessed the quality of the self-explanations using the same rating scale described for *Coached Practice*.

The fourth assigned practice game was *Map Conquest*. To access this activity, learners clicked on the *Map Conquest* icon in the left-most column entitled *Practice Games.* The practice activity began with a selected portion of the psychology text entitled *Personality Disorders* appearing on the screen with the target sentence in bold font. Learners were instructed to type and submit their self-explanations of the text. In *Map Conquest,* learners earned zero to three flags to build up their territories and conquer neighboring territories on a grid based upon the quality of the self-explanations they wrote (see Figure 9). iSTART assessed the quality of the self-explanations using the same formative rating scale described for *Coached Practice*. In this activity, the text was presented on six screens requiring learners to write six self-explanations. After the second, fourth, and sixth rounds, learners could place the flags they had earned on their own territories and then conquer neighboring territories. The learner competed against two automated opponents.

In addition to the four practice games, learners were asked to complete four mini games: *Strategy Match, Balloon Bust, Dungeon Escape,* and *Bridge Builder*. To access the four mini game activities, learners clicked on the respective icon in the center column entitled *Mini Games* on the *Practice* tab. In each of the mini games, learners were instructed to read a text and the computer-generated self-explanation of the target sentence. Afterwards, learners were asked to identify the type of strategy used to self-explain the target sentence. In *Strategy Match,* learners identified the strategy by dragging the strategy cards to the provided slots. Learners earned ten points for their first correct answer, and each correct consecutive answer was worth ten points more than the previous answer. A wrong answer resulted in a five-point reduction in score. In addition, after an incorrect answer was given, the next correct answer was worth ten points.

In *Balloon Bust,* learners clicked on the two balloons that identified the strategy used in the self-explanation. Learners earned 100 points for their first correct balloon and 50 points for their second correct balloon. A wrong answer resulted in a 50-point reduction in score and reduced the player's accuracy bonus. In *Dungeon Escape,* learners escaped a dungeon that was filling with water while the guards were asleep by selecting the doorways marked with the correct strategy. Learners earned points and their freedom from the dungeon by answering questions correctly. Conversely, learners lost points for wrong answers and the dungeon filled with more water. In *Bridge Builder,* learners built a bridge to help a character move from one side to another by dragging strategy blocks onto the bridge. Learners earned ten points for their first correct answer, and each correct consecutive answer was worth ten points more than the previous answer. A wrong answer resulted in a five-point reduction in score. In addition, the next correct answer was worth ten points.

According to McNamara, Levinstein, and Boonthum (2004), initial iSTART training modules (i.e., the instruction on self-explanation and the reading strategies) require about 30 minutes to complete. However, the researchers encouraged learners to engage in extended practice by utilizing some of the gaming technology incorporated into the system (Jackson, Boonthum, & McNamara, 2010). For this research, 40 minutes was allotted for completing the training modules. In addition, learners were introduced to several of the games in iSTART through eight assignments, which were estimated to require approximately two hours to complete. Table 56 provides a breakdown of the practice activities and the estimated time for completing them. Finally, learners were encouraged to practice independently. Learners' training progress and practice time on iSTART was tracked throughout the semester.

Table 56

Estimated Time for iSTART Practice Activities

Assignment	**Practice Activity**	**Practice Text**	**Minutes**
1	Practice Game - Coached Practice	*Learning*	10:00
	Mini Games – Strategy Match (after training)	Computer-selected	15:00
2	Practice Game - Coached Practice	*Causes and Effects of Mutations*	20:00
	Mini Games - Balloon Bust	Computer-selected	10:00
3	Practice Game - Self-Explanation Showdown	*Innate Behaviors*	20:00
	Mini Games – Dungeon Escape	Computer-selected	15:00
4	Practice Game – Map Conquest	*Personality Disorders*	15:00
	Mini Games – Bridge Builder	Computer-selected	15:00
Total Estimated Time for iSTART Practice Activities			**2:00:00**

Appendix B

DEMOGRAPHIC DATA

Student Survey #1 - Introduction

Start of Block: Default Question Block

Please click on the link below to read the Informed Consent for Students being asked to participate in this study.

Student Consent Form

Please type your name and email address in the signature boxes and indicate your choice of whether or not you will participate in this research.

○ First Name ____

○ Last Name ____

○ Email Address ____

○ I accept the terms in the form and volunteer to participate in the study

○ I will not participate in the study

Skip To: End of Survey If = I will not participate in the study.

We thank you for your time spent reading the informed consent form and for choosing to participate in this study! Your response has been recorded.

You may obtain a copy of the informed consent form by clicking the link below. You will have another opportunity to download this form at the end of the next survey. We will also email you a copy of the informed consent form for you to keep for your records.

Student Consent Form
When you are ready, please advance to the next question to complete the informational learner survey.

Please answer the following questions as they relate to you by filling in the blank or checking the appropriate boxes.

- ○ First Name ____
- ○ Last Name ____
- ○ Instructor Name ____________________________________
- ○ Course Section Number ________________________________
- ○ What is your age? ____________________________________
- ○ What is your gender? __________________________________

What is your race or ethnic origin? You may identify more than one racial or ethnic group.

- ☐ Black or African American
- ☐ Latino or Hispanic
- ☐ Asian / Pacific Islander
- ☐ Native American or American Indian
- ☐ White
- ☐ Other

If you selected "other" in the previous question, please write your race or ethnic origin in the space provided below.

____

*

What was your high school GPA? ___________________________________

*

What was your SAT/ACT Reading Score? ________________________________

What is your intended college major? __________________________________

Appendix C

IMPLICIT THEORIES OF INTELLIGENCE

Please provide the following information.

○ First Name ___________________________________

○ Last Name __________________________________

○ Email Address ________________________________

○ Instructor ____________________________________

○ UNIV116 Section Number _______________________

The following questions are exploring students' beliefs about their personal ability to change their intelligence level. There are no right or wrong answers. We are just interested in your views. Using the scale below, please indicate the extent to which you agree or disagree with the following statements.

I don't think I personally can do much to increase my intelligence.

1.	Strongly agree (1)	Agree (2)	Mostly agree (3)	Mostly disagree (4)	Disagree (5)	Strongly Disagree (6)
	○	○	○	○	○	○

My intelligence is something about me that I personally can't change very much.

2.	Strongly agree (1)	Agree (2)	Mostly agree (3)	Mostly disagree (4)	Disagree (5)	Strongly Disagree (6)
	○	○	○	○	○	○

Regardless of my current intelligence level, I think I have the capacity to change it quite a bit.

3.	Strongly agree (1)	Agree (2)	Mostly agree (3)	Mostly disagree (4)	Disagree (5)	Strongly Disagree (6)
	○	○	○	○	○	○

To be honest, I don't think I can really change how intelligent I am.

4.	Strongly agree (1)	Agree (2)	Mostly agree (3)	Mostly disagree (4)	Disagree (5)	Strongly Disagree (6)
	○	○	○	○	○	○

I believe I can always substantially improve on my intelligence.

5.	Strongly agree (1)	Agree (2)	Mostly agree (3)	Mostly disagree (4)	Disagree (5)	Strongly Disagree (6)
	○	○	○	○	○	○

I can learn new things, but I don’t have the ability to change my basic intelligence.

6.	Strongly agree (1)	Agree (2)	Mostly agree (3)	Mostly disagree (4)	Disagree (5)	Strongly Disagree (6)
	○	○	○	○	○	○

With enough time and effort I think I could significantly improve my intelligence level.

7.	Strongly agree (1)	Agree (2)	Mostly agree (3)	Mostly disagree (4)	Disagree (5)	Strongly Disagree (6)
	○	○	○	○	○	○

I believe I have the ability to change my basic intelligence level considerably over time.

8.	Strongly agree (1)	Agree (2)	Mostly agree (3)	Mostly disagree (4)	Disagree (5)	Strongly Disagree (6)
	○	○	○	○	○	○

Appendix D

ACHIEVEMENT GOALS

Below are twelve statements about learning. Please select a number from 1 to 6, (1 - indicating "I strongly disagree") and (6 - indicating "I strongly agree") that best indicates your level of agreement with each statement. There are no right or wrong answers. We are just interested in your views.

My aim is to completely master the material presented in this class.

(1)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

I am striving to do well compared to other students.

(2)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

My goal is to learn as much as possible.

(3)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

My aim is to perform well relative to other students.

(4)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

My aim is to avoid learning less than I possibly could.

(5)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

My goal is to avoid performing poorly compared to others.

(6)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

I am striving to understand the content of this course as thoroughly as possible.

(7)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

My goal is to perform better than the other students.

(8)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

My goal is to avoid learning less than it is possible to learn.

(9)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

I am striving to avoid performing worse than others.

(10)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

I am striving to avoid an incomplete understanding of the course material.

(11)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

My aim is to avoid doing worse than other students.

(12)	▼ 1 - I strongly disagree (1) ... 6 - I strongly agree (6)

Items from the Achievement Goal Questionnaire–Revised (AGQ-R)

Mastery-approach goal items
1 My aim is to completely master the material presented in this class.

3 My goal is to learn as much as possible.

7 I am striving to understand the content of this course as thoroughly as possible.

Mastery-avoidance goal items
5 My aim is to avoid learning less than I possibly could.

9 My goal is to avoid learning less than it is possible to learn.

11 I am striving to avoid an incomplete understanding of the course material.

Performance-approach goal items
2 I am striving to do well compared to other students.

4 My aim is to perform well relative to other students.

8 My goal is to perform better than the other students.

Performance-avoidance goal items
6 My goal is to avoid performing poorly compared to others.

10 I am striving to avoid performing worse than others.

12 My aim is to avoid doing worse than other students.

Appendix E

READING EFFICACY

The following statements are about your perceptions of reading college level texts. Choose one of the numbers below from the drop-down menu to indicate how true the statements are about you. There are no right or wrong answers. We are just interested in your views.

I will not have problems understanding even the most difficult texts that we read in college.

(1)	▼ 1 - Never True of Me (1) ... 10 - Always True of Me (10)

Compared with the others in my classes I have a good understanding of books that I read.

(2)	▼ 1 - Never True of Me (1) ... 10 - Always True of Me (10)

I am not particularly good at understanding the content of what I read.

(3)	▼ 1 - Never True of Me (1) ... 10 - Always True of Me (10)

I will probably have problems understanding much of what's in the textbooks this year.

(4)	▼ 1 - Never True of Me (1) ... 10 - Always True of Me (10)

Most of the others in my classes are probably better than me at understanding what they read.

(5)	▼ 1 - Never True of Me (1) ... 10 - Always True of Me (10)

It is easy for me to understand the content of textbooks.

(6)	▼ 1 - Never True of Me (1) ... 10 - Always True of Me (10)

I understand what I read well.

(7)	▼ 1 - Never True of Me (1) ... 10 - Always True of Me (10)

Original reading efficacy items

1. I will not have problems understanding even the most difficult texts that we read in ninth grade.
2. It is easy for me to understand the content of a book.
3. I am not particularly good at understanding the content of what I read (reversed).
4. I understand what I read well.
5. I will probably have problems understanding much of what's in the textbooks this school year (reversed).
6. Compared with the others in my class I have a good understanding of books that I read.
7. Most of the others in my class are probably better than me at understanding what they read (reversed).

Appendix F

PRIOR KNOWLEDGE

- First Name ______________________________________
- Last Name ______________________________________
- Email Address ____________________________________
- Instructor Name __________________________________
- Course Section ___________________________________

Prior knowledge questions (answers are highlighted)

Directions: The first part of this assessment will test your knowledge about the text that you will read next. Please select an answer for the following questions. This is a timed test. Once you begin, you will be given 5 minutes to answer 10 multiple-choice questions.

1. Linguistics is…

- a. The science that studies sounds.
- b. The collection of foundational laws of reasoning.
- c. The scientific study of language
- d. The art of public speaking.
- e. The collection of rules for debate and rebuttal.

2. Language divergence is the tendency of languages to…

- a. Transform into dialects and eventually become separate languages.
- b. Differ among people from different geographic regions.
- c. Play a distinctive role among people of different racial and ethnic origins.
- d. Serve as a cultural border between neighboring societies and domains.
- e. Perpetuate cultural norms and class separation in societies.

3. Dialects are…

- a. Social markers for separating members of a society by class.
- b. The standard literary language of a region or country.
- c. A literary tool used to enhance the language of theatrical performances
- d. A regional or social variety of the standard language of a culture.
- e. A cultural tool for learning new languages.

4. Romance languages are…

- a. A genre of medieval prose about love and adventure. (1)
- b. A group of languages of ancient Italian origin. (2)
- c. A class of literature that focuses on emotional attraction or aura. (3)
- d. A group of languages that are widely regarded as attractive to the ear. (4)
- e. A system of medieval languages used among the elite members of society. (5)

5. Sound shifts are…

- a. Changes in the way words are pronounced due to merging, dropping or changing vowels, consonants or syllables.
- b. The shock waves created by an object traveling through the air faster than the speed of sound.
- c. The movement of sound waves.
- d. The change in the sound of the voice through inflection or deflection, which often signals a shift in emotional state.
- e. Differences in the way sound is perceived by the hearer based upon distance and acoustic amplification.

6. Sanskrit is…

- a. The spoken language of Egyptian hieroglyphics.
- b. A group of languages spoken by Aboriginal Indians.
- c. Any language that can be written using letters or symbols.
- d. A language spoken by nomadic tribes in Northern Africa.
- e. An ancient language of India.

7. A language family is…

- a. A collection of diverse locations where people speak the same language.
- b. The collection of vowels, consonants and syllable sounds that are used to construct words in a particular language.
- c. A collection of many languages, all of which came from the same original tongue long ago.
- d. All the languages spoken in a particular region, country or continent.
- e. A grouping of similar words from different languages.

8. Language Reconstruction is…

a. The restoration of messages shared between two or more regional societies.

b. The deciphering of coded messages.

c. Systematically using language at the grassroots level to impact societal change.

d. Systematically using patterns of sounds and words to deduce a parent language or recreate an extinct language.

e. The systematic evaluation of a language to improve and reestablish it as a standardized version.

9. Language diffusion is…

a. The natural thinning out of a language over time due to changes in the way common words are used.

b. The spreading of a language from one area or group of people to another by social contact.

c. The natural thinning out of a language over time due to sudden decreases in the population.

d. The regional transformation of a language arising from civil discord.

e. The existence or continuation of language throughout the ages.

10. Language replacement is a process whereby…

◯ a. Immigrant families adopt the language of their new country of residence as their first language.

◯ b. Individuals adopt banned languages to protest on behalf of civil liberties.

◯ c. Language is used as a mechanism for peaceful protest against violence.

◯ d. Individuals filter out swear words to produce a less offensive language.

◯ e. Traditional languages are superseded, or greatly modified, by the language of more advanced cultures.

Appendix G

PRETEST READING COMPREHENSION STRATEGY USE

5-minute Quick-Write #1

The following question is inquiring about the types of reading comprehension strategies you usually use while reading. Remember, there are no right or wrong answers. We are just interested in your views. Please type your response in the space provided.

Please describe what you would do to improve your reading comprehension if after reading a chapter of text you did not understand what you had read. What strategies, if any, would you use? Explain your thinking.

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Appendix H

POSTTEST READING COMPREHENSION STRATEGY USE: SELF-EXPLAINING THE TEXT

Directions: Please begin the second reading comprehension assessment task by reading the text "Tracing Linguistic Diversification" as it appears on the screen. The text will appear in intervals of two or three sentences so that you will have time to think about the information as it is presented. We would also like you to write a self-explanation for ten sentences. These sentences will appear in **bold and highlighted** print. Please type your explanations in the text box that is provided for each required response.

This is a timed activity. Once you begin, you will be given 20 minutes to self-explain 10 target sentences.

TRACING LINGUISTIC DIVERSIFICATION

The diversification of languages has long been charted through the analysis of sound shifts. Take the Latin word for milk (lacte) and note that it becomes latta in Italian, leche in Spanish, and lait in French. Or the Latin for the number eight (octo), which becomes otto, ocho, and buit, respectively.

1 of 21

Even if the Latin roots for these words had never been known, linguists would have been able to deduce them. This technique of backward reconstruction is crucial to linguistic research. **If it is possible to deduce a large part of the vocabulary of an extinct language, it may be feasible to go even further and re-create the language that preceded it.**

2 of 21

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This technique, called deep reconstruction, has yielded some important results. It takes humanity's linguistic family tree back thousands of years.

3 of 21

More than two centuries ago William Jones, an Englishman living in South Asia, undertook a study of Sanskrit, the language in which ancient Indian religious and literary texts were written. **Jones discovered that the vocabulary and grammatical forms of Sanskrit bore a striking resemblance to the ancient Greek and Latin he had learned while in college.**

4 of 21

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During the nineteenth century Jacob Grimm, a scholar as well as a writer of fairy tales, suggested that sound shifts might prove the relationships between languages in a scientific manner. He pointed out that related languages have similar, but not identical, consonants. **He believed that these consonants would change over time in a predictable way.**

5 of 21

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Hard consonants, such as v and t in the German word later, would soften into vader (Dutch) and father (English). Looking backward, we should expect to find the opposite: a hardening of consonants.
From Jones' notions and Grimm's ideas came the first major linguistic hypothesis, which proposed the existence of an ancestral (Proto) Indo-European language (or closely related languages), the predecessor of Latin, Greek, and Sanskrit, among other ancient languages.

6 of 21

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This concept had major implications because the proposed ancestral language(s) would link not only the present and past Romance language but also a number of other languages spoken from Britain to North America and South Asia.

7 of 21

Proto-Indo-European gave rise to more than Latin, Greek, and Sanskrit. The Indo-European language realm includes not only languages derived from Latin but also the Slavonic (Slavic) languages, including Russian, Ukrainian, Polish, Czech, Slovak, Bulgarian, and Slovenian, and Germanic languages, including German, Swedish, Danish, and Norwegian. **These, too, must have had common ancestors, branches of the Proto-Indo-European "tree."**

8 of 21

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The first scholar to compare the world's language families to the branches of a tree was August Schleicher, a German linguist. In the mid-nineteenth century he suggested that the basic process of language formation is language divergence, that is, differentiation over time and space.

9 of 21

Languages would branch into dialects; isolation then increased the differences between dialects. **Over time, dialects would become discrete languages, as happened with Quebecois French.**

10 of 21

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Although this idea was later challenged, it stood the test of time, and the language-tree model remains central to language research. A complicating factor, however is human mobility.

11 of 21

While languages diverged, people migrated as well. **Languages did not merely diffuse through static populations; they were also spread by relocation diffusion.**

12 of 21

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Sometimes diffusion caused long-isolated languages to make contact, creating language convergence. Such instances create special problems for researchers because the rules of construction may not apply or may be unreliable.

13 of 21

A further complication should be considered in view of modern cultural events. We know that the languages of traditional, numerically smaller, and technologically less advanced peoples have been replaced, or greatly modified, by the languages of invaders. **This process of language replacement goes on today, and there is every reason to believe that it has happened ever since humans began to use language.**

14 of 21

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Reconstructing even a small branch of the language tree, therefore, is a complicated task. If only all languages were members of the same family, the same branch of the tree! Hungarian, for instance, completely surrounded by Indo-European languages, is not in the same family as any of its neighbors.

15 of 21

Finnish is another non-Indo-European language, apparently distantly related to Hungarian but mapped as a member of a discrete subfamily. Estonian is more closely related to Finnish.

16 of 21

But a tantalizing enigma is presented by Basque, a family that is now isolated in a small region of northern Spain and southwestern France. What ancient proto-language gave rise to Basque? **Similar questions arise in hundreds of places throughout the world, linguistic islands survive despite later waves of language diffusion.**

17 of 21

While linguistics reconstructed Proto-Indo-European vocabulary, human geographers and other scholars searched for the source of Proto-Indo-European. Identifying this hearth would enormously increase their understanding of Eurasian historical geography.

18 of 21

The linguists' research produced many clues. The proto-languages had words for certain landforms, trees, and other features of the natural landscape, but it lacked others. **Such information helps reveal the environment in which a language may have developed.**

19 of 21

For example, if a reconstructed language has no word for snow, this would suggest a tropical or equatorial origin. If there is no word for palm tree, the language is likely to have emerged in a cold region.

20 of 21

Time is less an issue when vocabulary refers to physiographic features of the landscape. If there are many words for mountains and hills but few for flat land, we can conclude that the source area is mountainous.

21 of 21

Appendix I

READING COMPREHENSION

Target Text – “Tracing Linguistic Diversification”

The diversification of languages has long been charted through the analysis of sound shifts. Take the Latin word for milk *(lacte)* and note that it becomes *latta* in Italian, *leche* in Spanish, and *lait* in French. Or the Latin for the number eight *(octo)*, which becomes *otto*, *ocho*, and *buit*, respectively. Even if the Latin roots for these words had never been known, linguists would have been able to deduce them.

This technique of backward reconstruction is crucial to linguistic research. **If it is possible to deduce a large part of the vocabulary of an extinct language, it may be feasible to go even further and re-create the language that preceded it.** This technique called deep reconstruction, has yielded some important results. It takes humanity's linguistic family tree back thousands of years.

More than two centuries ago William Jones, an Englishman living in South Asia, undertook a study of Sanskrit, the language in which ancient Indian religious and literary texts were written. **Jones discovered that the vocabulary and grammatical forms of Sanskrit bore a striking resemblance to the ancient Greek and Latin he had learned while in college**.

During the nineteenth century Jacob Grimm, a scholar as well as a writer of fairy tales, suggested that sound shifts might prove the relationships between languages in a scientific manner. He pointed out that related languages have similar, but not identical, consonants. **He believed that these consonants would change over time in a predictable way.** Hard consonants, such as **v** and **t** in the German word later, would soften into va**d**er (Dutch) and **f**ather (English). Looking backward, we should expect to find the opposite: a hardening of consonants.

From Jones' notions and Grimm's ideas came the first major linguistic hypothesis, which proposed the existence of an ancestral *(Proto) Indo-European* language (or closely related languages), the predecessor of Latin, Greek, and Sanskrit, among other ancient languages. This concept had major implications because the proposed ancestral language(s) would link not only the present and past Romance language but also a number of other languages spoken from Britain to North America and South Asia.

Proto-Indo-European gave rise to more than Latin, Greek, and Sanskrit. The Indo-European language realm includes not only languages derived from Latin but also the

Slavonic (Slavic) languages, including Russian, Ukrainian, Polish, Czech, Slovak, Bulgarian, and Slovenian, and Germanic languages, including German, Swedish, Danish, and Norwegian. **These, too, must have had common ancestors, branches of the Proto-Indo-European "tree."**

The first scholar to compare the world's language families to the branches of a tree was August Schleicher, a German linguist. In the mid-nineteenth century he suggested that the basic process of language formation is language divergence, that is, differentiation over time and space. Languages would branch into dialects; isolation then increased the differences between dialects. **Over time, dialects would become discrete languages, as happened with Quebecois French.** Although this idea was later challenged, it stood the test of time, and the language-tree model remains central to language research.

A complicating factor, however is human mobility. While languages diverged, people migrated as well. **Languages did not merely diffuse through static populations; they were also spread by relocation diffusion.** Sometimes diffusion caused long-isolated languages to make contact, creating language convergence. Such instances create special problems for researchers because the rules of construction may not apply or may be unreliable.

A further complication should be considered in view of modern cultural events. We know that the languages of traditional, numerically smaller, and technologically less advanced peoples have been replaced, or greatly modified, by the languages of invaders. **This process of language replacement goes on today, and there is every reason to believe that it has happened ever since humans began to use language**.

Reconstructing even a small branch of the language tree, therefore, is a complicated task. If only all languages were members of the same family, the same branch of the tree! Hungarian, for instance, completely surrounded by Indo-European languages, is not in the same family as any of its neighbors. Finnish is another non-Indo-European language, apparently distantly related to Hungarian but mapped as a member of a discrete subfamily. Estonian is more closely related to Finnish. But a tantalizing enigma is presented by Basque, a family that is now isolated in a small region of northern Spain and southwestern France. What ancient proto-language gave rise to Basque? **Similar questions arise in hundreds of places throughout the world, linguistic islands survive despite later waves of language diffusion.**

While linguistics reconstructed Proto-Indo-European vocabulary, human geographers and other scholars searched for the source of Proto-Indo-European. Identifying this hearth would enormously increase their understanding of Eurasian historical geography.

The linguists' research produced many clues. The proto-languages had words for certain landforms, trees, and other features of the natural landscape, but it lacked others. **Such information helps reveal the environment in which a language may have developed.** For example, if a reconstructed language has no word for snow, this would suggest a tropical or equatorial origin. If there is no word for palm tree, the language is likely to have emerged in a cold region. Time is less an issue when vocabulary refers to physiographic features of the landscape. If there are many words for mountains and hills but few for flat land, we can conclude that the source area is mountainous.

Reading Comprehension Assessment

Directions: The third part of this assessment will test your understanding of the text you just read. Please provide a typewritten response to the following questions in the textboxes that are provided. **This is a timed test. Once you begin, you will be given 20 minutes to write an answer for 8 questions.**

For your convenience, the entire passage you just read is provided below.

<u>Textbase (TB) Questions and Answers (Q&A)</u>

TBQ1 What is the primary goal of deep reconstruction?

TBA1 If it is possible to deduce a large part of the vocabulary of an extinct language, it may be feasible to go even further and re-create the language that preceded it. This technique called deep reconstruction, has yielded some important results. **(proximate text)**

TBQ2 What is language divergence?

TBA2 In the mid-nineteenth century he suggested that the basic process of language formation is language divergence, that is, differentiation over time and space. Languages would branch into dialects; isolation then increased the differences between dialects. Over time, dialects would become discrete languages, as happened with Quebecois French. **(proximate text)**

TBQ3 What is language convergence?

TBA3 Languages did not merely diffuse through static populations; they were also spread by relocation diffusion. Sometimes diffusion caused long-isolated languages to make contact, creating language convergence. **(proximate text)**

<u>**Situation Model – Bridging (SMB) Questions and Answers (Q&A)**</u>

SMBQ1 What challenges have made it difficult for linguists to retrace the evolution of language?

SMBA1

A. A complicating factor, however is human mobility. While languages diverged, people migrated as well. Languages did not merely diffuse through static populations; they were also spread by relocation diffusion. Sometimes diffusion caused long-isolated languages to make contact, creating **language convergence**. Such instances create special problems for researchers because the rules of construction may not apply or may be unreliable.

B. A further complication should be considered in view of modern cultural events. We know that the languages of traditional, numerically smaller, and technologically less advanced peoples have been **replaced, or greatly modified, by the languages of invaders**.

SMBQ2 How does the way in which human geographers go about retracing the evolution of language differ from the methods used by linguists?

SMBA2

A. The first scholar to compare the world's language families to the branches of a tree was August Schleicher, a German linguist. In the mid-nineteenth century he suggested that the basic process of language formation is language divergence, that is, differentiation over time and space. Languages would branch into dialects; isolation then increased the differences between dialects. Over time, dialects would become discrete languages, as happened with Quebecois French. Although this idea was later challenged, it stood the test of time, and the language-tree model remains central to language research.

B. While linguistics reconstructed Proto-Indo-European vocabulary, human geographers and other scholars searched for the source of Proto-Indo-European. Identifying this hearth would enormously increase their understanding of Eurasian historical geography.

C. The linguists' research produced many clues. The proto-language(s) had words for certain landforms, trees, and other features of the natural landscape, but it lacked others. Such information helps reveal the environment in which a language may have developed. For example, if a reconstructed language has no word for snow, this would suggest a tropical or equatorial origin. If there is no word for palm tree, the language is likely to have emerged in a cold region. Time is less an issue when vocabulary refers to physiographic features of the landscape. If there are many words for mountains and hills but few for flat land, we can conclude that the source area is mountainous.

SMBQ3 In the last paragraph of the text, the author writes, "Time is less an issue when vocabulary refers to physiographic features of the landscape". What does the author mean by this statement?

SMBA3

A. The first scholar to compare the world's language families to the branches of a tree was August Schleicher, a German linguist. In the mid-nineteenth century he suggested that the basic process of language formation is language divergence, that is, differentiation over time and space. Languages would branch into dialects; isolation then increased the differences between dialects. **Over time, dialects would become discrete languages, as happened with Quebecois French.** Although this idea was later challenged, it stood the test of time, and the language-tree model remains central to language research.

B. The linguists' research produced many clues. The proto-languages had words for certain landforms, trees, and other features of the natural landscape, but it lacked others. **Such information helps reveal the environment in which a language may have developed.** For example, if a reconstructed language has no word for snow, this would suggest a tropical or equatorial origin. If there is no word for palm tree, the language is likely to have emerged in a cold region. Time is less an issue when vocabulary refers to physiographic features of the landscape. If there are many words for mountains and hills but few for flat land, we can conclude that the source area is mountainous.

<u>Situation Model – Elaboration (SME) Questions and Answers (Q&A)</u>

SMEQ1 Describe how language divergence may be in process today? Explain your thinking.

SMEA1 Response should provide an example based on the following description of language divergence: *"In the mid-nineteenth century he suggested that the basic process of language formation is language divergence, that is, differentiation over time and space. Languages would branch into dialects; isolation then increased the differences between dialects. Over time, dialects would become discrete languages, as happened with Quebecois French."*

SMEQ2 The researchers who study the origins of languages believe that the process of determining relationships among language families should extend beyond identifying words that appear to have a common ancestry. They believe it is also important to understand **why** the words are similar. Why do you think understanding **why words are similar** may be important to figuring out if or how languages are related?

SMEA2 When studying language origins it is important to understand why words are similar because it has become increasingly difficult to determine whether some languages truly share a common line of ancestry, versus whether they only share certain borrowed words or if the observed similarities are by sheer chance or accident. Any two randomly selected languages in the world will show a certain percentage of apparent similarities, even in basic vocabulary. That's because there is a limited number of sounds in human languages. There are also certain built-in constraints on the form of human languages, which makes accidental resemblance quite possible and frequent.

This concept is not directly addressed in the text, however there is information in the text that can serve as a starting point for answering the question, specifically the discussion regarding the complexity of ways languages can change over time...

Appendix J

PRETEST READING SKILL ASSESSMENT

The first two passages (questions 1-10) are released SAT practice exercises from the College Board (2014).
https://collegereadiness.collegeboard.org/sample-questions/reading/1

The final passage (questions 11-20) is a released ACT (n.d.) practice exercise.
http://www.actstudent.org/sampletest/reading/read_02.html

Please provide the following information.

- First Name ____
- Last Name ____
- Email Address ______________________________________
- Instructor ____
- UNIV116 Section Number ____________________________

This assessment consists of three passages. Each reading passage below is accompanied by a set of questions based on the passage and any additional material that is given. Answer the questions according to what is stated or implied in the passage. This is a timed test. Once you begin, you will be given 15 minutes to answer 20 multiple-choice questions. Questions 1-5 are based on the following passage.

This passage is adapted from Edith Wharton, *Ethan Frome,* originally published in 1911. Mattie Silver is Ethan's household employee.

Mattie Silver had lived under Ethan's roof for a year, and from early morning till they met at supper he had frequent chances of seeing her; but no moments in her company were comparable to those when, her arm in his, and her light step flying to keep time with his long stride, they walked back through the night to the farm. He had taken to the girl from the first day, when he had driven over to the Flats to meet her, and she had smiled and waved to him from the train, crying out, “You must be Ethan!” as she jumped down with her bundles, while he reflected, looking over her slight person: “She don’t look much on housework, but she ain’t a fretter, anyhow.” But it was not only that the coming to his house of a bit of hopeful young life was like the lighting of a fire on a cold hearth. The girl was more than the bright serviceable creature he had thought her. She had an eye to see and an ear to hear: he could show her things and tell her things, and taste the bliss of feeling that all he imparted left long reverberations and echoes he could wake at will.

It was during their night walks back to the farm that he felt most intensely the sweetness of this communion. He had always been more sensitive than the people about him to the appeal of natural beauty. His unfinished studies had given form to this sensibility and even in his unhappiest moments field and sky spoke to him with a deep and powerful persuasion. But hitherto the emotion had remained in him as a silent ache, veiling with sadness the beauty that evoked it. He did not even know whether anyone else in the world felt as he did, or whether he was the sole victim of this mournful privilege. Then he learned that one other spirit had trembled with the same touch of wonder: that at his side, living under his roof and eating his bread, was a creature to whom he could say: “That’s Orion down yonder; the big fellow to the right is Aldebaran, and the bunch of little ones—like bees swarming—they’re the Pleiades...” or whom he could hold entranced before a ledge of granite thrusting up through the fern while he unrolled the huge panorama of the ice age, and the long dim stretches of succeeding time. The fact that admiration for his learning mingled with Mattie’s wonder at what he taught was not the least part of his pleasure. And there were other sensations, less definable but more exquisite, which drew them together with a shock of silent joy: the cold red of sunset behind winter hills, the flight of cloud-flocks over slopes of golden stubble, or the intensely blue shadows of hemlocks on sunlit snow.

When she said to him once: “It looks just as if it was painted!” it seemed to Ethan that the art of definition could go no farther, and that words had at last been found to utter his secret soul....

As he stood in the darkness outside the church these memories came back with the poignancy of vanished things. Watching Mattie whirl down the floor from hand to hand he wondered how he could ever have thought that his dull talk interested her. To him, who was never gay but in her presence, her gaiety seemed plain proof of indifference. The face she lifted to her dancers was the same which, when she saw him, always looked like a window that has caught the sunset. He even noticed two or three gestures which, in his fatuity, he had thought she kept for him: a way of throwing her head back when she was amused, as if to taste her laugh before she let it out, and a trick of sinking her lids slowly when anything charmed or moved her.

1. Over the course of the passage, the main focus of the narrative shifts from the

◯ A. reservations a character has about a person he has just met to a growing appreciation that character has of the person's worth.

◯ B. ambivalence a character feels about his sensitive nature to the character's recognition of the advantages of having profound emotions.

◯ C. intensity of feeling a character has for another person to the character's concern that that intensity is not reciprocated.

◯ D. value a character attaches to the wonders of the natural world to a rejection of that sort of beauty in favor of human artistry.

2. In the context of the passage, the author's use of the phrase "her light step flying to keep time with his long stride" (line 4) is primarily meant to convey the idea that

◯ A. Ethan and Mattie share a powerful enthusiasm.

◯ B. Mattie strives to match the speed at which Ethan works.

◯ C. Mattie and Ethan playfully compete with each other.

◯ D. Ethan walks at a pace that frustrates Mattie.

3. The description in the first paragraph indicates that what Ethan values most about Mattie is her

- A. fitness for farm labor.
- B. vivacious youth.
- C. receptive nature.
- D. freedom from worry.

4. Which choice provides the best evidence for the answer to the previous question?

- A. Lines 1–5 (“Mattie...farm”)
- B. Lines 5–9 (“He had...anyhow”)
- C. Lines 9–11 (“But it...hearth”)
- D. Lines 12–14 (“She had...will”)

5. The author includes the descriptions of the sunset, the clouds, and the hemlock shadows (lines 32–34) primarily to

- A. suggest the peacefulness of the natural world.
- B. emphasize the acuteness of two characters’ sensations.
- C. foreshadow the declining fortunes of two characters.
- D. offer a sense of how fleeting time can be.

Questions 6-10 are based on the passages below.

In the reading below, passage 1 is adapted from Susan Milius, “A Different Kind of Smart.” Copyright 2013 by Science News. Passage 2 is adapted from Bernd Heinrich, *Mind of the Raven: Investigations and Adventures with Wolf-Birds*. Copyright 2007 by Bernd Heinrich.

<u>Passage 1</u>

In 1894, British psychologist C. Lloyd Morgan published what's called Morgan's canon, the principle that suggestions of humanlike mental processes behind an animal's behavior should be rejected if a simpler explanation will do.

Line 5

Still, people seem to maintain certain expectations, especially when it comes to birds and mammals. "We somehow want to prove they are as 'smart' as people," zoologist Sara Shettleworth says. We want a bird that masters a vexing problem to be employing human-style insight.

New Caledonian crows face the high end of these expectations, as possibly the second-best toolmakers on the planet.

Line 11

Their tools are hooked sticks or strips made from spike-edged leaves, and they use them in the wild to winkle grubs out of crevices. Researcher Russell Gray first saw the process on a cold morning in a mountain forest in New Caledonia, an island chain east of Australia. Over the course of days,

Line 15

he and crow researcher Gavin Hunt had gotten wild crows used to finding meat tidbits in holes in a log. Once the birds were checking the log reliably, the researchers placed a spiky tropical pandanus plant beside the log and hid behind a blind.

Line 19

A crow arrived. It hopped onto the pandanus plant, grabbed the spiked edge of one of the long straplike leaves and began a series of ripping motions. Instead of just tearing away one long strip, the bird ripped and nipped in a sequence to create a slanting stair-step edge on a leaf segment with a narrow point and a wide base. The process took only seconds. Then the bird dipped the narrow end of its leaf strip into a hole in the log, fished up the meat with the leaf-edge spikes, swallowed its prize and flew off.

Line 26

"That was my 'oh wow' moment," Gray says. After the crow had vanished, he picked up the tool the bird had left behind. "I had a go, and I couldn't do it," he recalls. Fishing the meat out was tricky. It turned out that Gray was moving the leaf shard too forcefully instead of gently stroking the spines against the treat.

Line 31

The crow's deft physical manipulation was what inspired Gray and Auckland colleague Alex Taylor to test other wild crows to see if they employed the seemingly insightful string-pulling solutions that some ravens, kea parrots and other brainiac birds are known to employ. Three of four crows passed that test on the first try.

Passage 2

For one month after they left the nest, I led my four young ravens at least once and sometimes several times a day on thirty-minute walks. During these walks, I wrote down everything in their environment they pecked at. In the first sessions, I tried to be teacher. I touched specific objects—sticks,

Line 5

moss, rocks—and nothing that I touched remained untouched by them. They came to investigate what I had investigated, leading me to assume that young birds are aided in learning to identify food from the parents' example. They also, however, contacted almost everything else that lay directly in their own paths. They soon became more independent by taking their own routes near mine. Even while walking along on their own, they pulled at leaves, grass stems, flowers, bark, pine needles, seeds, cones, clods of earth, and other objects they encountered. I wrote all this down, converting it to numbers. After they were thoroughly familiar with the background objects in these woods and started to ignore them, I seeded the path we would later walk together with objects they had never before encountered. Some of these were conspicuous food items: raspberries, dead meal worm beetles, and cooked corn kernels. Others were conspicuous and inedible: pebbles, glass chips, red winterberries. Still others were such highly cryptic foods as encased caddisfly larvae and moth cocoons. The results were dramatic.

The four young birds on our daily walks contacted all new objects preferentially. They picked them out at a rate of up to tens of thousands of times greater than background or previously contacted objects. The main initial criterion for pecking or picking anything up was its novelty. In subsequent trials, when the previously novel items were edible, they became preferred and the inedible objects became "background" items, just like the leaves, grass, and pebbles, even if they were highly conspicuous. These experiments showed that ravens' curiosity ensures exposure to all or almost all items in the environment.

6. Within Passage 1 the main purpose of the first two paragraphs is to

A. offer historical background in order to question the uniqueness of two researchers' findings.

B. offer interpretive context in order to frame the discussion of an experiment and its results.

C. introduce a scientific principle in order to show how an experiment's outcomes validated that principle.

D. present seemingly contradictory stances in order to show how they can be reconciled empirically.

7. According to the experiment described in Passage 2 , whether the author's ravens continued to show interest in a formerly new object was dictated primarily by whether that object was

- A. edible
- B. plentiful
- C. conspicuous
- D. natural

8. The crows in Passage 1 and the ravens in Passage 2 shared which trait?

- A. They modified their behavior in response to changes in their environment.
- B. They formed a strong bond with the humans who were observing them.
- C. They manufactured useful tools for finding and accessing food.
- D. They mimicked the actions they saw performed around them.

9. One difference between the experiments described in the two passages is that unlike the researchers discussed in Passage 1, the author of Passage 2

- A. presented the birds with a problem to solve.
- B. intentionally made the birds aware of his presence.
- C. consciously manipulated the birds' surroundings.
- D. tested the birds' tool using abilities.

10. Is the main conclusion presented by the author of Passage 2 consistent with Morgan's canon, as described in Passage 1?

- A. Yes, because the conclusion proposes that the ravens' behavior is a product of environmental factors.
- B. Yes, because the conclusion offers a satisfyingly simple explanation of the ravens' behavior.
- C. No, because the conclusion suggests that the ravens exhibit complex behavior patterns.
- D. No, because the conclusion implies that a humanlike quality motivates the ravens' behavior.

Questions 11-20 are based on the following passage.

NATURAL SCIENCE: This passage is adapted from the article "How to Build a Baby's Brain" by Sharon Begley (©1997 by Newsweek, Inc.). In this selection, the term *neuron* refers to a specialized cell of the nervous system, and *tomography* refers to a method of producing three-dimensional images of internal structures.

You cannot see what is going on inside your newborn's brain. You cannot see the electrical activity as her eyes lock onto yours and, almost instantaneously, a neuron in her retina makes a connection to one in her brain's visual cortex that will last all her life. The image of your face has become an enduring memory in her mind. And you cannot see the explosive release of a neurotransmitter—brain chemical—as a neuron from your baby's ear, carrying the electrically encoded sound of "ma," connects to a neuron in her auditory cortex. "Ma" has now commandeered a cluster of cells in the infant's brain that will, as long as the child lives, respond to no other sound.

You cannot see any of this. But Dr. Harry Chugani can come close. With positron-emission tomography PET), Chugani, a pediatric neurobiologist, watches the regions of a baby's brain turn on, one after another, like city neighborhoods having their electricity restored after a blackout. He can measure activity in the primitive brain stem and sensory cortex from the moment the baby is born. He can observe the visual cortex burn with activity in the second and third months of life. He can see the frontal cortex light up at 6 to 8 months. He can see, in other words, that the brain of a baby is still forming long after the child has left the womb—not merely growing bigger, but forming the microscopic connections responsible for feeling, learning and remembering.

Scientists are just now realizing how experiences after birth, rather than something innate, determine the actual wiring of the human brain. Only 15 years ago neuroscientists assumed that by the time babies are born, the structure of their brains had been genetically determined. But by 1996, researchers knew that was wrong. Instead, early-childhood experiences exert a dramatic and precise impact, physically determining how the intricate neural circuits of the brain are wired. Since then they have been learning how those experiences shape the brain's circuits.

At birth, the brain's 100 billion or so neurons form more than 50 trillion connections (synapses). The genes the baby carries have already determined his brain's basic wiring. They have formed the connections in the brain stem that will make the heart beat and the lungs respire. But that's all. Of a human's 80,000 different genes, fully half are believed to be involved in forming and running the central nervous system. Yet even that doesn't come close to what the brain needs. In the first months of life, the number of synapses will increase 20-fold—to more than 1,000 trillion. There simply are not enough genes in the human species to specify so many connections.

That leaves experience—all the signals that a baby receives from the world. Experience seems to exert its effects by strengthening synapses. Just as a memory will fade if it is not accessed from time to time, so synapses that are not used will also wither away in a process called pruning. The way to reinforce these wispy connections has come to be known as stimulation. Contrary to the claims of entrepreneurs preying on the anxieties of new parents, stimulation does not mean subjecting a toddler to flashcards. Rather, it is something much simpler—sorting socks by color or listening to the soothing cadences of a fairy tale. In the most extensive study yet of what makes a difference, Craig Ramey of the University of Alabama found that it was blocks, beads, peekaboo and other old-fashioned measures that enhance cognitive, motor and language development—and, absent traumas, enhance them permanently.

The formation of synapses (synaptogenesis) and their pruning occurs at different times in different parts of the brain. The sequence seems to coincide with the emergence of various skills. Synaptogenesis begins in the motor cortex at about 2 months. Around then, infants lose their “startle” and “rooting” reflexes and begin to master purposeful movements. At 3 months, synapse formation in the visual cortex peaks; the brain is fine-tuning connections allowing the eyes to focus on an object. At 8 or 9 months the hippocampus, which indexes and files memories, becomes fully functional; only now can babies form explicit memories of, say, how to move a mobile. In the second half of the first year, finds Chugani, the prefrontal cortex, the seat of forethought and logic, forms synapses at such a rate that it consumes twice as much energy as an adult brain. That furious pace continues for the child’s first decade of life.

11. The main point of this passage is to:

- A. illustrate the importance of genetics in the formation of a baby's brain.
- B. illustrate the importance of stimulation and experience in the formation of a baby's brain.
- C. indicate the great need for conducting further research on babies' brains.
- D. compare the latest research on babies' brains with similar research conducted fifteen years ago.

12. The main point made in the second, third, and fourth paragraphs (lines 14–52) is that the structure of a baby's brain:

- A. is genetically determined before the child is born.
- B. can be seen through positron-emission tomography.
- C. can be altered through a process known as pruning.
- D. is still developing after the child is born.

13. According to the passage, one thing PET allows neurobiologists to do is:

- A. observe activity in the frontal cortex of a baby's brain.
- B. determine the number of genes involved in the formation of a baby's brain.
- C. control the release of neurotransmitters in a baby's auditory cortex.
- D. restore microscopic connections in a baby's brain.

14. When she compares a baby's brain to city neighborhoods, the author is most nearly illustrating her point that:

- A. neurotransmitters are actually brain chemicals.
- B. regions of the brain are awakened through experience.
- C. the visual cortex allows a baby to recognize specific images.
- D. a baby's brain has about 1,000 trillion synapses.

15. Which of the following would the author of the passage be LEAST likely to recommend as a way to strengthen the synapses of a baby's brain?

- A. Reading to a baby
- B. Playing peekaboo with a baby
- C. Teaching a baby with flashcards
- D. Showing a baby how to distinguish red socks from blue blocks

16. The last paragraph suggests that the formation of synapses occurs most rapidly:

- A. during the first two months of a child's life.
- B. during the first nine months of a child's life.
- C. from the time a child is about six months old until that child is about ten years old.
- D. from the time a child is about one year old until that child is well into adolescence.

17. As it is used in line 30, the phrase *something innate* most nearly means:

◯ A. a memory.

◯ B. learned behavior.

◯ C. physical immaturity.

◯ D. an inherited trait.

18. As it is used in line 30, the phrase *something innate* most nearly means:

◯ A. a lack of stimulation.

◯ B. learned behavior.

◯ C. physical immaturity.

◯ D. an inherited trait.

19. When the author refers to "entrepreneurs preying on the anxieties of new parents" (lines 60–61), she is most likely suggesting that new parents should:

◯ A. give their babies products such as flashcards only if they have examined these products carefully.

◯ B. not be deceived by advertising that claims certain products will increase a baby's intelligence.

◯ C. not worry if their babies' development is slightly behind that suggested by neurobiologists.

◯ D. take their pediatrician's advice before they listen to the advice given by other family members.

20. The passage states that, in terms of development, the average baby should be able to:

- A. focus his or her eyes on an object at two months of age.
- B. develop a "startle" reflex at about two months of age.
- C. make logical connections between ideas at about four months of age.
- D. form explicit memories at about nine months of age.

Appendix K

POSTTEST READING SKILL ASSESSMENT

The first two passages (questions 1-10) are released SAT practice exercises from College Board (2014)
https://collegereadiness.collegeboard.org/sample-questions/reading/1

The final passage (questions 12-20) is a released ACT practice exercise.
http://www.actstudent.org/sampletest/reading/read_02.html
Reading Skill Assessment2

- First Name ____
- Last Name ____
- Email Address ____
- Instructor Name ____
- Course Section ____

This assessment consists of three passages. Each reading passages below is accompanied by a set of questions based on the passage and any additional material that is given. Answer the questions according to what is stated or implied in the passage. This is a timed test. Once you begin, you will be given 15 minutes to answer 20 multiple-choice questions.

Questions 1–5 are based on the following passage and supplementary material.

This passage is adapted from Ed Yong, "Turtles Use the Earth's Magnetic Field as Global GPS." ©2011 by Kalmbach Publishing Co.

In 1996, a loggerhead turtle called Adelita swam across 9,000 miles from Mexico to Japan, crossing the entire Pacific on her way. Wallace J. Nichols tracked this epic journey with a satellite tag. But Adelita herself had no such technology at her disposal. How did she steer a route across two oceans to find her destination?

Nathan Putman has the answer. By testing hatchling turtles in a special tank, he has found that they can use the Earth's magnetic field as their own Global Positioning System (GPS). By sensing the field, they can work out both their latitude and longitude and head in the right direction.

Line 9

Putman works in the lab of Ken Lohmann, who has been studying the magnetic abilities of loggerheads for over 20 years. In his lab at the University of North Carolina, Lohmann places hatchlings in a large water tank surrounded by a large grid of electromagnetic coils. In 1991, he found that the babies started in the opposite direction if he used the coils to reverse the direction of the magnetic field around them. They could use the field as a compass to get their bearing.

Line 15

Later, Lohmann showed that they can also use the magnetic field to work out their position. For them, this is literally a matter of life or death. Hatchlings born off the sea coast of Florida spend their early lives in the North Atlantic gyre, a warm current that circles between North America and Africa. If they're swept towards the cold waters outside the gyre, they die. Their magnetic sense keeps them safe.

Line 20

Using his coil-surrounded tank, Lohmann could mimic the magnetic field at different parts of the Earth's surface. If he simulated the field at the northern edge of the gyre, the hatchlings swam southwards. If he simulated the field at the gyre's southern edge, the turtles swam west-northwest. These experiments showed that the turtles can use their magnetic sense to work out their latitude—their position on a north-south axis. Now, Putman has shown that they can also determine their longitude—their position on an east-west axis.

Line 27

He tweaked his magnetic tanks to simulate the fields in two positions with the same latitude at opposite ends of the Atlantic. If the field simulated the west Atlantic near Puerto Rico, the turtles swam northeast. If the field matched that on the east Atlantic near the Cape Verde Islands, the turtles swam southwest. In the wild, both headings would keep them within the safe, warm embrace of the North Atlantic gyre.

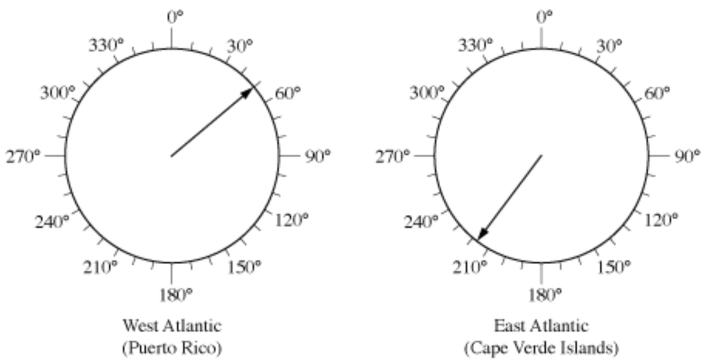
Line 32

Before now, we knew that several animal migrants, from loggerheads to reed warblers to sparrows, had some way of working out longitude, but no one knew how. By keeping the turtles in the same conditions, with only the magnetic fields around them changing, Putman clearly showed that they can use these fields to find their way. In the wild, they might well also use other landmarks like the position of the sea, sun and stars.

Line 38

Putman thinks that the turtles work out their position using two features of the Earth's magnetic field that change over its surface. They can sense the field's inclination, or the angle at which it dips towards the surface. At the poles, this angle is roughly 90 degrees and at the equator, it's roughly zero degrees. They can also sense its intensity, which is strongest near the poles and weakest near the Equator. Different parts of the world have unique combinations of these two variables. Neither corresponds directly to either latitude or longitude, but together, they provide a "magnetic signature" that tells the turtle where it is.

Orientation of Hatchling Loggerheads Tested in Magnetic Fields



Adapted from Nathan Putman, Courtney Endres, Catherine Lohmann, and Kenneth Lohmann, "Longitude Perception and Bicoordinate Magnetic Maps in Sea Turtles." ©2011 by Elsevier Inc.

Orientation of hatchling loggerheads tested in a magnetic field that simulates a position at the west side of the Atlantic near Puerto Rico (left) and a position at the east side of the Atlantic near the Cape Verde Islands (right). The arrow in each circle indicates the mean direction that the group of hatchlings swam. Data are plotted relative to geographic north

1. The passage most strongly suggests that Adelita used which of the following to navigate her 9,000-mile journey?

- A. The current of the North Atlantic gyre
- B. Cues from electromagnetic coils designed by Putman and Lohmann
- C. The inclination and intensity of Earth's magnetic field
- D. A simulated "magnetic signature" configured by Lohmann

2. Which choice provides the best evidence for the answer to the previous question?

- A. Lines 1–2 (“In 1996...way”)
- B. Lines 20–21 (“Using...surface”)
- C. Lines 35–37 (“In the wild...stars”)
- D. Lines 43–45 (“Neither...it is”)

3. Based on the passage, which choice best describes the relationship between Putman’s and Lohmann’s research?

- A. Putman’s research contradicts Lohmann’s.
- B. Putman’s research builds on Lohmann’s.
- C. Lohmann’s research confirms Putman’s.
- D. Lohmann’s research corrects Putman’s.

4. The author refers to reed warblers and sparrows (line 32-33) primarily to

- A. contrast the loggerhead turtle’s migration patterns with those of other species.
- B. provide examples of species that share one of the loggerhead turtle’s abilities.
- C. suggest that most animal species possess some ability to navigate long distances.
- D. illustrate some ways in which the ability to navigate long distances can help a species.

5. It can reasonably be inferred from the passage and graphic that if scientists adjusted the coils to reverse the magnetic field simulating that in the East Atlantic (Cape Verde Islands), the hatchlings would most likely swim in which direction?

- A. Northwest
- B. Northeast
- C. Southeast
- D. Southwest

Questions 6–10 are based on the following passage.

This passage is adapted from a speech delivered by Congresswoman Barbara Jordan of Texas on July 25, 1974, as a member of the Judiciary Committee of the United States House of Representatives. In the passage, Jordan discusses how and when a United States president may be impeached, or charged with serious offenses, while in office. Jordan's speech was delivered in the context of impeachment hearings against then president Richard M. Nixon.

Today, I am an inquisitor. An hyperbole would not be fictional and would not overstate the solemnness that I feel right now. My faith in the Constitution is whole; it is complete; it is total. And I am not going to sit here and be an idle spectator to the diminution, the subversion, the destruction, of the Constitution.

"Who can so properly be the inquisitors for the nation as the representatives of the nation themselves?" "The subjects of its jurisdiction are those offenses which proceed from the misconduct of public men."* And that's what we're talking about. In other words, [the jurisdiction comes] from the abuse or violation of some public trust.

It is wrong, I suggest, it is a misreading of the Constitution for any member here to assert that for a member to vote for an article of impeachment means that that member must be convinced that the President should be removed from office. The Constitution doesn't say that. The powers relating to impeachment are an essential check in the hands of the body of the legislature against and upon the encroachments of the executive. The division between the two branches of the legislature, the House and the Senate, assigning to the one the right to accuse and to the other the right to judge—the framers of this Constitution were very astute. They did not

make the accusers and the judges...the same person.
Line 19
We know the nature of impeachment. We've been talking about it a while now. It is chiefly designed for the President and his high ministers to somehow be called into account. It is designed to "bridle" the executive if he engages in excesses. "It is designed as a method of national inquest into the conduct of public men."* The framers confided in the Congress the power, if need be, to remove the President in order to strike a delicate balance between a President swollen with power and grown tyrannical, and preservation of the independence of the executive.
Line 26
The nature of impeachment: a narrowly channeled exception to the separation of powers maxim. The Federal Convention of 1787 said that. It limited impeachment to high crimes and misdemeanors, and discounted and opposed the term "maladministration." "It is to be used only for great misdemeanors," so it was said in the North Carolina ratification convention. And in the Virginia ratification convention: "We do not trust our liberty to a particular branch. We need one branch to check the other."
Line 33
...The North Carolina ratification convention: "No one need be afraid that officers who commit oppression will pass with immunity." "Prosecutions of impeachments will seldom fail to agitate the passions of the whole community," said Hamilton in the Federalist Papers, number 65. "We divide into parties more or less friendly or inimical to the accused."* I do not mean political parties in that sense.
Line 39
The drawing of political lines goes to the motivation behind impeachment; but impeachment must proceed within the confines of the constitutional term "high crime[s] and misdemeanors." Of the impeachment process, it was Woodrow Wilson who said that "Nothing short of the grossest offenses against the plain law of the land will suffice to give them speed and effectiveness. Indignation so great as to overgrow party interest may secure a conviction; but nothing else can."
Line 46
Common sense would be revolted if we engaged upon this process for petty reasons. Congress has a lot to do: appropriations, tax reform, health insurance, campaign finance reform, housing, environmental protection, energy sufficiency, mass transportation. Pettiness cannot be allowed to stand in the face of such overwhelming problems. So today we're not being petty. We're trying to be big, because the task we have before us is a big one.

*Jordan quotes from *Federalist* No. 65, an essay by Alexander Hamilton, published in 1788, on the powers of the United States Senate, including the power to decide cases of impeachment against a president of the United States.

6. The stance Jordan takes in the passage is best described as that of

- A. an idealist setting forth principles.
- B. an advocate seeking a compromise position.
- C. an observer striving for neutrality.
- D. a scholar researching a historical controversy.

7. The main rhetorical effect of the series of three phrases beginning in line 4 (“the diminution, the subversion, the destruction”) is to

- A. convey with increasing intensity the seriousness of the threat Jordan sees to the Constitution.
- B. clarify that Jordan believes the Constitution was first weakened, then sabotaged, then broken.
- C. indicate that Jordan thinks the Constitution is prone to failure in three distinct ways.
- D. propose a three-part agenda for rescuing the Constitution from the current crisis.

8. As used in line 26, “channeled” most nearly means

- A. worn
- B. sent
- C. constrained
- D. siphoned

9. In lines 34–38 (“Prosecutions...sense”), what is the most likely reason Jordan draws a distinction between two types of “parties”?

A. To counter the suggestion that impeachment is or should be about partisan politics

B. To disagree with Hamilton’s claim that impeachment proceedings excite passions

C. To contend that Hamilton was too timid in his support for the concept of impeachment

D. To argue that impeachment cases are decided more on the basis of politics than on justice

10. Which choice provides the best evidence for the answer to the previous question?

A. Lines 10–13 (“It...office”)

B. Lines 15–18 (“The division...astute”)

C. Lines 39–41 (“The drawing...misdemeanors”)

D. Lines 47–49 (“Congress...transportation”)

Questions 11–20 are based on the following passage.
This passage is adapted from “A Poem of One’s Own,” an essay by Mary Jo Salter in which she discusses feminist literary critics’ recent reappraisal of women’s writing. The essay was taken from *Audiences and Intentions: A Book of Arguments* (©1994 by Macmillan College Publishing Company, Inc.).

The time is overdue to admit that there is something of a vacuum in women’s poetry, and that we abhor it. For a woman to concede this is not disloyal to her sex; it’s the first step in the creation of an environment in which women artists will flourish. But what can be done about the fact that the list of beloved women poets is not as long as the list of beloved poets who were born male?

The most liberating response to the problem was the one Elizabeth Bishop chose. As James Merrill writes, “Lowell called her one of the four best women poets ever—which can hardly have pleased Miss Bishop, who kept her work from appearing in ‘women’s anthologies.’ Better, from her point of view, to be one of the forty, or forty thousand, best *poets*, and have done with it.” And he adds, “If I raise the issue at all, it’s to dissociate her from these shopworn polarities.” For the working poet, moved by the sexless sunset or the sex-indeterminate beetle, the polarities are indeed shopworn, but perhaps as readers we may pursue the issue an inch further. For one thing that we can do about these two unequal lists is to read women poets of the past who have never been much read and to discover whether or not they deserve to be.

Emily Dickinson, after all, would never have become one of the most revered poets in the world had her sister Lavinia not rescued her poems from the obscurity of a dresser drawer; and had her editor Mabel Loomis Todd not painstakingly transcribed nearly illegible scraps using a bizarre typewriter. Helen Hunt Jackson, that once celebrated, now forgotten poet whose work Dickinson herself admired, was another “sister” in this story, for she alone fully understood Dickinson’s gifts. Jackson wrote to Dickinson urging her to publish: “You are a great poet—and it is wrong to the day you live in, that you will not sing aloud,” her letter went. “When you are what men call dead, you will be sorry you were so stingy.” That has to be one of the most moving moments in American literary history.

And yet, and yet. Another reason many of us are devoted to Dickinson is that we love the romance of her story. Dickinson has to be one of the luckiest great writers who ever lived. She chose to live in isolation, which meant she was saved from the corruption of the literary crowd; no husband ever patted her head dismissively, no child ever interrupted her, and when her life was finished a team of disciples ensured her immortality. If we do the necessary work of reappraising the literary “canon,” and if we add some new women’s names to the reading list, we will nonetheless have to settle for discoveries less dramatic than Lavinia Dickinson’s, and we can’t expect them to appear with frequency.

For the fact is that we can’t have it both ways. We can’t simultaneously espouse the line that women haven’t until recently been allowed the depth of education and experience to become Shakespeare, while also claiming that we really have an abundance of Shakespeares, if anybody would just take the time to read us.

But what is all this rating and counting and classifying of authors about anyway? If we set up one writer against another, aren’t we giving in to what some feminists tell us is the adversarial mentality of patriarchal culture? We may think of Matthew Arnold’s view of the function of criticism—“to learn and propagate the best that is known and thought”—and squirm in our chairs: Who’s to say what is best, who’s to say what is relevant?

Theoretically, these questions are of some interest. Practically speaking, most of us who are habitual readers of poetry already have an answer. While acknowledging our profound differences of taste, we never doubt that there are good poems and terrible poems, and that the good ones are the only ones we have time for.

What else can be done about the fact that the list of the best women poets is not as long as the men’s list? In addition to looking closely for unjustly neglected women, one might question whether some men poets have been overrated. I think, for some reason, of poets whose names contain double Ws—William Wordsworth, Walt Whitman, William Carlos Williams—and while I would be sorry to throw out the entire oeuvre of them, I confess that each of these poets has at times bored me to tears.

The problem with taking men poets down a peg, however, is that it's hard to do so with discernment. The zeal to undo, immediately, the centuries of neglect and abuse endured by women poets has resulted in the devaluation of great poets who were born male and (far worse) in the devaluation of poetry itself.

11. Which of the following most fully lists solutions considered by the author to the problem that the list of beloved women poets is not nearly as long as the list of beloved men poets?

A. Reading women poets who have never been read, rejecting the writing of those whose names contain double Ws, and redefining what's good about the literary canon

B. Reappraising the literary canon, adding new women's names to the list, weighing the importance of some male poets, and reading work by women as yet not widely read

C. Questioning the importance of some male poets, encouraging readers to study women's journals, and creating a world in which women will flourish

D. Promoting the best work of current women writers, rediscovering older writers, reappraising Matthew Arnold's view of criticism, and acknowledging differences in literary taste

12. Which of the following sentences best summarizes the first paragraph?

A. It is disloyal to encourage women to write, and to ask: Why do male poets flourish more readily than female poets?

B. We must ask why there are so few women writers; perhaps asking this question will help create a women-centered culture.

C. It can be liberating to ask questions such as: What can be done about the fact that there are fewer beloved male poets than female poets?

D. If we admit that there is not enough quality poetry written by women, it can make it easier to discover why this is so, and help us change the situation.

13. It may reasonably be inferred from lines 10–17 that James Merrill respected Elizabeth Bishop's poetry:

A. and wished that reaction to her poems had not been complicated by gender issues.

B. but was disturbed by her refusal to be included in women's anthologies.

C. but felt she should be more concerned with women's issues.

D. and was glad she was one of the four best women poets ever.

14. According to the third paragraph (lines 25–39), Emily Dickinson's career was helped by Helen Hunt Jackson, who:

A. published her; Mabel Loomis Todd, who transcribed her writing; and Lavinia Dickinson, who discovered her poems in a cabinet.

B. encouraged her; Mabel Loomis Todd, who transcribed her work using a bizarre machine; and Lavinia Dickinson, who rescued her work from oblivion.

C. encouraged her sister to keep writing; Mabel Loomis Todd, who convinced her to use a typewriter; and Lavinia Dickinson, who rescued her poems from a dresser drawer.

D. taught her; Mabel Loomis Todd, who translated her writing into English; and Lavinia Dickinson, who introduced her poems to the public.

15. Which of the following most clearly distinguishes between the “two ways” suggested by the author’s assertion that “we can’t have it both ways” (line 54)?

◯ A. Women haven’t until recently been allowed to see the depths in Shakespeare, but nobody bothers to read Shakespeare anyway.

◯ B. Women haven’t written as well as men because they’ve been too busy being spouses, but nobody takes time to read women writers anyway.

◯ C. Women haven’t written as well as men because they have not had the same educational opportunities, yet there are many great women writers no one reads.

◯ D. Women have always had an abundance of Shakespeare, yet have not experienced the kind of education it takes to appreciate Shakespeare.

16. The author feels that “all this rating and counting and classifying of authors“ (lines 61–62) is:

◯ A. an example of giving in to a competitive approach to literature, which the author feels is counterproductive.

◯ B. an example of an approach to literature that feminists have supported and should continue to support.

◯ C. at odds with Matthew Arnold’s view of the function of criticism, a view that the author endorses.

◯ D. important, especially if it helps eliminate the entire oeuvre of writers whose names contain double Ws.

17. Which of the following best states the author’s response to Matthew Arnold’s view of the function of criticism (lines 65–76)?

- A. It makes her reflect on why criticism is always so negative, yet she knows that most people don’t read criticism.
- B. It makes her uncomfortable because so many respect Matthew Arnold, yet she realizes his ideas about poetry are now irrelevant.
- C. It makes her wonder who decides what is good, yet she knows most readers think they know what good poetry is and don’t have time to read bad poetry.
- D. It makes her question why more women don’t read Matthew Arnold, yet she realizes that few women today would find Arnold’s views engaging.

18. Which of the following most nearly paraphrases Helen Hunt Jackson’s statement to Emily Dickinson that “it is wrong to the day you live in, that you will not sing aloud” (lines 35–36)?

- A. It is morally reprehensible of you not to let other poets read your work.
- B. It is unacceptable for you to continue writing; you should become a singer.
- C. It is stingy and wrong of you not to read out loud to those who like your work.
- D. It is unfair to this age that you do not share your poetry with the world.

19. It may reasonably be inferred that the author considers Emily Dickinson “one of the luckiest great writers who ever lived” (lines 42–43) in part because:

- A. her writing was discovered in such a dramatic way by her editor.
- B. she lived such a romantic life, dressing in white and enjoying many suitors.
- C. she was never interrupted by her disciples.
- D. she lived in isolation, which allowed her much time to write.

20. The last paragraph suggests that those who would reevaluate, and perhaps want to devalue, the work of famous male poets should above all be:

- A. cautious.
- B. decisive.
- C. opinionated.
- D. zealous.

Appendix L

MATERIALS FOR GROWTH-MINDSET TREATMENT CONDITION

The *Growth Mindset Video* is available at:

https://www.youtube.com/watch?v=ElVUqv0v1EE

Mindsets and Math/Science Achievement
Carol S. Dweck - Stanford University 2008

Why do some people reach their full potential, while others of equal talent, do not?

After three decades of extensive research, Dr. Carol Dweck asserts that success is directly related to people's beliefs about their intelligence and talent. Those who believe their gifts and intelligence are innate and carved in stone have a "fixed mindset", whereas those who believe that their abilities and intelligence can be developed through effort and practice have a "growth mindset". The effects of one's mindset on life choices and resulting achievements are profound.[1]

Fixed Mindset

Some people don't know abilities can change —they operate with a fixed mindset. These people believe that they have a certain amount of intelligence that cannot be changed. When they encounter something that is very hard for them, this belief causes them to quit too early because they don't think they can succeed.

Individuals who hold the implicit belief that intelligence and talents are fixed tend to be concerned about proving their abilities, rather than learning. This belief causes them to interpret mistakes as threats to their ego rather than as opportunities to improve. Mistakes defeat their self-confidence because they attribute errors to lack of ability, which they feel powerless to change. Consequently, in order to decrease the likelihood of making mistakes, and increase the likelihood of demonstrating their skill or intelligence, these individuals tend to avoid challenges. 2

Individuals with a fixed mindset often avoid making a concerted effort in their endeavors - in classrooms, on the field, or in pursuit of personal goals, fearing that hard work indicates a lack of ability or intelligence, prevents them from reaching their full potential.[3]

Growth Mindset

Individuals with a growth mindset, on the other hand, tend to demonstrate the kind of perseverance and resilience required to convert life's setbacks into future successes. The growth mindset is the belief that your basic qualities and abilities are things that you can change and grow. Through effort, the right strategies and getting help from others, you can achieve more than you thought you could.

Individuals with a growth mindset believe intelligence and skills can be developed through education and hard work. They want to stretch themselves and learn. Challenges are motivating rather than intimidating, as they present opportunities to grow their skills and intellect, enabling them to work towards audacious goals and achieve their full potential.

Another significant difference between individuals with growth and fixed mindsets is in their ability to accurately self-assess. Those with a growth mindset are more "open to accurate information about their current abilities, even if it's unflattering", because they believe they can develop and improve. "Since they're oriented toward learning... they need accurate information about their current abilities in order to learn effectively." Those with a fixed mindset, however, tend to have distorted or unrealistic views of their abilities.[4]

Research: College Achievement

A 2003 study by psychologists Heidi Grant of Columbia University and Carol Dweck of Stanford University examined college students' achievement as they coped with one of the most challenging and important courses: pre-med organic chemistry. In this study, we focused on students' goals—how much they focused on learning vs. how much they were concerned with proving their intelligence though their schoolwork. Research has shown that these goals are closely related to mindsets. Students with the growth mindset tend to take on learning goals and students with fixed mindsets tend to focus on proving their intelligence.

In this study, Grant and Dweck found that:

- A growth mindset, compared to a fixed ability mindset, predicted higher final grades in the organic chemistry course.
- Growth mindset learners' grade advantage was caused by their use of deeper learning strategies.
- A fixed mindset predicted students' failure to recover from earning a poor grade.
- A growth mindset predicted successful recovery after earning a poor grade.

Learners' mindsets had a dramatic impact on their performance. At the start of the course, the expectations of students with a growth mindset were comparable to those who displayed a fixed mindset, but as the work became more difficult, students with a growth mindset showed greater persistence. As a result, growth mindset learners' exam scores overtook those of fixed mindset learners and the gap between the two groups continued to widen during the semester.

While people do differ in intelligence and ability, research is converging on the conclusion that accomplishments are typically the result of years of passion and dedication and not something that flows naturally from a gift. American Idol's Jennifer Hudson, Thomas Edison, Michael Jordan, and Mozart were not simply born with talent; they cultivated it through tremendous and sustained effort. Consequently, if we foster development of a growth mindset, we can empower ourselves to love challenges and believe in effort, thereby helping ourselves to achieve our full potential.

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Prepared for the Carnegie Corporation of New York-Institute for Advanced Study Commission on Mathematics and Science Education

Experimental Condition Fidelity Check – Growth-Mindset Group

Summary of Growth-Mindset Treatment Condition:

You've just viewed a video and read an article about how your brain can change. During this 10-minute exercise, write a paragraph of not more than 250 words to summarize the major scientific ideas you learned from the video and research article.

Advice Letters to a Struggling High-School Student:

You've heard a lot about how your abilities can grow and change. You've read about scientific studies that show that people can grow connections in their brain and can improve through effort, strategies, and help from others. Now we'd like you to help us teach a high school student that people's ability can change.

Imagine that you are a volunteer mentor for students at a local high school. One of the students you are mentoring shares with you that they are becoming discouraged at school because they do not believe they are "good at learning." Using the information you learned about in the video and article, what could you say to help him or her understand that abilities can change?

(adapted from Thrive, 2011a)

Thrive Foundation for Youth • www.stepitup2thrive.org

www.stepitup2thrive.org/downloads/lessons/mindset/M3b_Advice_letter.pdf

Appendix M

MATERIALS FOR CONTROL TREATMENT CONDITION

The Teen Brain: Under Construction video is available at:

http://www.bing.com/videos/search?q=The+Teen+Brain%3a+Under+Construction&view

=detail&mid=A4EE6644BF689567172AA4EE6644BF689567172A&FORM=VIRE

"Zooming to New Connections: A Summary of Brain Growth in Adolescence"
J. Prelutsky - American University, 2008

Neuroscience is the study of the brain, and this field has exploded with new information. Recent technology inventions enable scientists to take pictures of brains that are alive and growing. We now know that adolescents undergo profound brain growth and brain change far into their twenties. By then, the brain is "the most complicated three-pound mass of known matter in the universe."

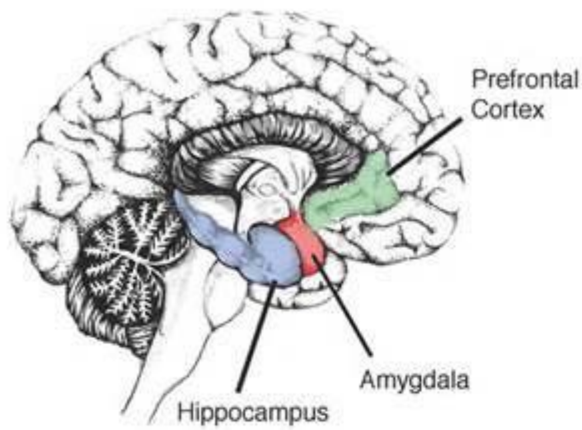
Brain Power—Pruning Gray Matter and Growing White Matter

The gray matter of the brain represents the nerve cell bodies with the genetic DNA. There are over 100 billion of these cells. The cells on the right side of the brain have the DNA that controls the left side of the body, and the left brain controls the right side. Therefore, when an individual feels an itch on his right leg, the brain hemisphere on the opposite left side is recording that itch. During adolescence, the cells in this gray matter slim down. They are cast off just as an artist carves rock to make a sculpture, leaving rock crumbs behind. Nature carves the brain to eliminate cell connections that are seldom used, and nature strengthens connections that will assist one's thoughts and actions. This brain re-organization is called pruning. In adolescence, youth influence what stays and what goes, through their effort and choice of experiences.

The white matter is composed of long nerve trunks called axons, which are covered in white fat—hence the name.

The white fat, called myelin, helps electrical impulses travel very fast. One brain cell is connected to 1,000 to 5,000 other cells, creating a vast web of nerve connections that sends information to muscles, at 250 miles per second. The white matter grows increasingly dense in adolescence, in a back to front direction. There is a zone of reason and judgment, in the Prefrontal Cortex, and it develops last. Youth have an enormous window of opportunity to shape brain development in a positive or damaging direction.

The brain grows in response to mental challenge, in the same way muscles respond to exercise.



Amygdala—The "Rock-and-Roll" Center

A brain area called the Amygdala (see the brain diagram) processes strong emotion such as danger and fear, or what people call emotions from the "gut". Music triggers this center too, and this explains why music and emotion are so hand-in-hand.

In adolescence, hormones in puberty excite the Amygdala to mature first. This fact is proven in scientific studies comparing youth responses to adults. When youth and adults are asked to identify emotions expressed on faces, magnetic imaging of brains shows that the Amygdala fires in youth, while the front of the brain (the prefrontal cortex) fires in adult brains. Adults have an advantage in this task until the prefrontal cortex is mature, about the age of twenty-five.

There is good reason for this staging of brain growth. The Amygdala growth enhances the youths' ability to connect feelings with memories of past situations that might be important. This time of intense emotion naturally triggers youth to seek personal identity and a way to define themselves in the world.

Brain Folds—Increase Information

Science proves teens shape their own development. Emotional learning, high-level thinking, and positive experiences build complex brains. The brain's ruffled, folded surface increases its folds. This evolving pattern of folds and crevices reaches a peak by the late teens, and then the brain folds remains stable throughout adult life. These folds increase the flow of information. If folds were laid out end to end, they would equal the size of an open newspaper. Humans join cats, dogs, monkeys and dolphins in having these unique, folded brains. All other animals have primitive flat brains, which provide less brain surface to support creativity of thought.

Protect that Dopamine!

Nerve cells talk to each other all the time, but they never actually touch. They meet in a space called a synapse. When an electrical impulse travels down the axon, it changes to a chemical impulse, crosses the synapse, and then converts back to an electrical impulse on the next axon. Special chemicals, carry the impulse across the synapse.

Reasoning cells in the Prefrontal Cortex, communicate by releasing the chemical Dopamine into synapses between cells. These Dopamine-rich cells grow rapidly in the teen years. They help the brain make decisions, and they coordinate using memory to make difficult choices. Dopamine cells also increase the capacity for impulse control. Drugs such as cocaine and amphetamine target dopamine cells and damage them. Ecstasy permanently destroys nerve cells and connections.

In summary, an adolescent has a brain full of promise. A writer of A. Nonny Mouse Writes Again! sums it up: "Ashes to ashes, dust to dust, oil those brains, before they rust."

Experimental Condition Fidelity Check –Control Group

Summary of Control Group Treatment Condition:

You've just viewed a video and read an article about the adolescent brain. During this 10-minute writing exercise, write a paragraph of not more than 250 words to summarize the major scientific ideas you learned from the video and research article.

Advice Letters to a Struggling High-School Student:

You've read a lot about how the brain works. You've also heard about the adolescent brain. Given what you now know, we'd like you to help us reach out to a high school student in need of advice.

Imagine that you are a volunteer mentor for students at a local high school. One of the students you are mentoring shares with you that they are becoming discouraged at school because they do not believe they are "good at learning." Drawing on the information you learned today, as well as your experiences, what could you say to help this student decide their next steps?

(adapted from Thrive, 2011a)

Thrive Foundation for Youth • www.stepitup2thrive.org

www.stepitup2thrive.org/downloads/lessons/mindset/M3b_Advice_letter.pdf

Appendix N

EXPERIMENTAL CONDITION SUSTAINED FIDELITY CHECK

5-minute Quick-Write #3

The following question is inquiring about how you would encourage a struggling learner. Remember, there are no right or wrong answers. We are just interested in your views. Please type your response in the space provided.

Suppose one of your classmates tells you that they are thinking about dropping out of college because college is much harder than high school. Explain how you might encourage them to complete their degree.

Appendix O

EVALUATION OF iSTART STRATEGY USE: 5-MINUTE QUICK-WRITE

The following question is inquiring about your use of the iSTART reading comprehension strategies in other classes. Remember, there are no right or wrong answers. We are just interested in your views. Please type your response in the space provided.

Have you tried to use any iSTART strategies in other courses? If you have, please describe the strategy or strategies you have used, as well as how you used them. If you have not used any of the strategies in another class as yet, please explain any circumstances that have prevented you from using the strategies.

____

____

Appendix P

EVALUATION OF iSTART STRATEGY USE: UTILITY AND COST VALUE

The following questions ask about your beliefs and thoughts about using the strategies you learned in iSTART. Remember there are no right or wrong answers; just answer as accurately as possible. Use the scale below to answer the questions. If you think the statement is very true of you, select 7; if a statement is not at all true of you, select 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

1. I think I will be able to use the strategies I learned in iSTART in other courses.

	▼ 1 - Not at all true of me ... 7 - Very true of me

2. I think using the iSTART strategies requires too much effort.

	▼ 1 - Not at all true of me ... 7 - Very true of me

3. I think using the iSTART strategies demands too much of my time.

	▼ 1 - Not at all true of me ... 7 - Very true of me

4. It is important for me to learn the strategies taught in iSTART.

	▼ 1 - Not at all true of me ... 7 - Very true of me

5. I have to put too much energy into using the iSTART strategies.

	▼ 1 - Not at all true of me ... 7 - Very true of me

6. I am very interested in the strategies I learned in iSTART.

▼ 1 - Not at all true of me ... 7 - Very true of me

7. I think using iSTART strategies take up too much time.

▼ 1 - Not at all true of me ... 7 - Very true of me

8. I think the iSTART strategies taught in this course is useful for me to learn.

▼ 1 - Not at all true of me ... 7 - Very true of me

9. I think using the iSTART strategies is too much work.

▼ 1 - Not at all true of me ... 7 - Very true of me

10. I like the iSTART strategies taught in this course.

▼ 1 - Not at all true of me ... 7 - Very true of me

11. Understanding the iSTART strategies taught in this course is very important to me.

▼ 1 - Not at all true of me ... 7 - Very true of me

Appendix Q

EVALUATION OF iSTART STRATEGY USE: LEARNERS' PERSPECTIVES

The following questions are exploring students' use of the iSTART strategies you were taught. Remember, there are no right or wrong answers. We are just interested in your views. Please type your response to each question in the space provided.

The next two questions ask about the amount of reading you have been required to do this semester and whether you used any of the iSTART strategies you were taught to help you complete your reading tasks.

Please complete the table below by filling in:
Column 1 - The name of each course you took this semester
Column 2 - The average number of pages of required reading each week
Column 3 - Which iSTART strategies, if any, did you use in each course? Select all that apply.

Which iSTART Strategy Did You Use?							
Name of Course	# of Pages	None	Monitoring	Paraphrasing	Bridging	Elaboration	Prediction
		☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐

Briefly describe how often **AND** how you have used the iSTART strategies in other courses.

Which iSTART strategy (or strategies) is (or are) most useful? Please explain your thinking.

How, if at all, has using the iSTART strategies affected your ability to understand difficult texts? Explain your thinking.

Appendix R

PATTERNS OF ADAPTIVE LEARNING SCALES (PALS): APPROACHES TO INSTRUCTION

INSTRUCTOR SURVEY

Name: ____

Course Number: UNIV116 Section Number: __________

The following questions are about your perceptions of your teaching style. There are no right or wrong answers. We are just interested in your views. Using the scale below, please indicate the extent to which you agree or disagree with the following statements.

In my course:

1. I give special privileges to students who do the best work. **1** STRONGLYDISAGREE **2** **3** SOMEWHAT AGREE **4** **5** STRONGLY AGREE
2. I make a special effort to recognize students' individual progress, even if they are below course standards. **1** STRONGLYDISAGREE **2** **3** SOMEWHAT AGREE **4** **5** STRONGLY AGREE
3. I display the work of the highest achieving students as an example. **1** STRONGLYDISAGREE **2** **3** SOMEWHAT AGREE **4** **5** STRONGLY AGREE

4. I often provide several different activities/assignments so that students can choose among them. **1 2 3 4 5** **STRONGLYDISAGREE SOMEWHAT AGREE STRONGLY AGREE**
5. I consider how much students have improved when I assign grades. **1 2 3 4 5** **STRONGLYDISAGREE SOMEWHAT AGREE STRONGLY AGREE**
6. I help students understand how their performance compares to others. **1 2 3 4 5** **STRONGLYDISAGREE SOMEWHAT AGREE STRONGLY AGREE**
7. I encourage students to compete with each other. **1 2 3 4 5** **STRONGLYDISAGREE SOMEWHAT AGREE STRONGLY AGREE**
8. I point out those students who do well as a model for the other students. **1 2 3 4 5** **STRONGLYDISAGREE SOMEWHAT AGREE STRONGLY AGREE**
9. I give a wide range of assignments, matched to students' needs and skill level. **1 2 3 4 5** **STRONGLYDISAGREE SOMEWHAT AGREE STRONGLY AGREE**

Appendix S

INSTRUCTOR INTERVIEW PROTOCOL

STRATEGIES FOR ACADEMIC SUCCESS

Name: ________________________ Email Address: ________________________

Course Number: UNIV116 Section Number: ________________

The first set of questions focus on general information about your UNIV116 course sections.

Consider the learners in your three sections of UNIV116…

1. Please describe the purpose of your UNIV116 course sections? What knowledge or awareness do you try to bring to light for learners in your course sections?
2. What are your learning objectives for your UNIV116 course sections?
3. What principles or standards, if any, do you try to impart to the learners in your UNIV116 course sections?
4. Tell me about the topics you taught in this course this semester.
5. Other than iSTART, what other academic skill areas, if any, did you cover in the course? Please describe or give some examples of how you taught the skills you covered in the course.
6. What proportion of this course was devoted to each major topic and/or skill area?
7. What are your impressions of learners' thoughts about the purpose of UNIV116?
    a. Why do you suppose learners perceive the course this way?

The next set of questions focus on your perceptions of learners' academic engagement in your UNIV116 course sections.

8. How responsive are the learners in your UNIV116 course sections to completing assignments in a timely manner so they are prepared for class meetings?
    a. What steps, if any, do you take to encourage learners to come prepared for class meetings?
    b. How, if at all, do you respond to learners who are not prepared for class meetings?
        i. How, if at all, have learners responded to your efforts to encourage them to prepare for class meetings?

9. What are your perceptions of the degree of diligence displayed by learners in your course sections for following task directions and maintaining attention until tasks are completed?
    a. Why do you suppose that's so? or
    b. What do you think accounts for some of the differences in the degree of diligence learners display?
    c. As an instructor, how do you respond to learners who display a lack of diligence while working on academic tasks – for instructions or maintaining attention?
10. Please describe your perceptions of how learners in your course sections respond when work is difficult.
    a. What about when learners think the work is boring?
    b. Please describe how learners typically communicate to you that they believe their work is difficult or boring?
        ii. What are your expectations regarding students' academic response to work when it is difficult?
        iii. What are your expectations regarding students' academic response when students are uninterested in their work?

In the second set of questions about learners' academic engagement in your UNIV116 course sections I would like to talk with you about your students' experiences working with the iSTART automated tutoring system.

11. Some students were very slow to get started and or complete the iSTART training and practice modules. Why do you suppose these students had a slow start and or finish regarding the iSTART training? What experiences lead you to these conclusions?
12. How valuable, if at all, do you think the iSTART strategies are for beginning college learners? Please explain your thinking.
13. How valuable, if at all, do you believe students in your course sections found the iSTART strategies? What experiences lead you to these conclusions?
14. All activity has a cost, in terms of time, effort, stress and trading off valued alternatives. What are your thoughts on students' perspectives about the cost of learning and practicing the iSTART reading comprehension strategies? Please explain your thinking.
15. What types of questions, if any, did students in your course sections ask about using the strategies taught in iSTART?
    a. How did you respond these questions?
16. Please tell me what comments, if any, students made about using the strategies taught in iSTART?
    a. What was your response to these comments?
17. Are there any other experiences with iSTART that stand out in your recollection that you would like to share at this time?

The final set of questions focus on your perceptions of learners' general college engagement.

18. What do you believe to be the main reasons why learners in your UNIV116 course sections choose to attend college?
    a. How, if at all, have differences in learners' reasons for attending college played out in their academic performances during the first semester?
19. What are your impressions of the beginning college learners in your UNIV116 courses in terms of their preparedness to be successful at college?
    a. What do you see as their main strengths and weaknesses for succeeding at college?
    b. Did you notice differences among the learners by course section?
        i. What do you suppose accounts for those differences across your course sections?
20. Based on your experiences with the learners, how do you think they feel about being a part of the Associate in Arts program?
    a. How, if at all, do you think learners' feelings about the Associates in Art program vary based upon whether their enrollment was by university decision or personal choice?
21. What differences in students' academic behaviors have you observed in your course and in college in general, based upon whether their enrollment in the AA Program was by university decision or personal choice?
22. During the semester, I noticed that you had to advise some of your students on academic planning and choices, how would you describe your students' approach to their academic careers, particularly when they think the work is or will be difficult?

Thank you for your time.

Appendix T

IRB HUMAN SUBJECTS APPROVAL LETTERS

UNIVERSITY OF DELAWARE

RESEARCH OFFICE

210 Hullihen Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

DATE:	October 5, 2016
TO:	Helene Delpeche
FROM:	University of Delaware IRB
STUDY TITLE:	[952474-1] The implicit and the explicit: The impact of teaching academic mindsets and reading strategies on beginning college learners' reading comprehension and achievement
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
APPROVAL DATE:	October 4, 2016
EXPIRATION DATE:	October 3, 2017
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # *(7)*

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All SERIOUS and UNEXPECTED adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All sponsor reporting requirements should also be followed.

Please report all NON-COMPLIANCE issues or COMPLAINTS regarding this study to this office.

Please note that all research records must be retained for a minimum of three years.

Based on the risks, this project requires Continuing Review by this office on an annual basis. Please use the appropriate renewal forms for this procedure.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.

UNIVERSITY OF DELAWARE

RESEARCH OFFICE

210 Hullihen Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

DATE:	September 14, 2017
TO:	Helene Delpeche
FROM:	University of Delaware IRB
STUDY TITLE:	[952474-4] The implicit and the explicit: The impact of teaching academic mindsets and reading strategies on beginning college learners' reading comprehension and achievement
SUBMISSION TYPE:	Continuing Review/Progress Report
ACTION:	APPROVED
APPROVAL DATE:	September 14, 2017
EXPIRATION DATE:	October 3, 2018
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # *(7)*

Thank you for your submission of Continuing Review/Progress Report materials for this research study. The University of Delaware IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

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If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.