UNIVERSITY OF CALIFORNIA,
IRVINE

Bridging Mindset Theory and Attribution Theory: A Longitudinal Exploration of Students' Belief Patterns in Their Early Years of College

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Education

by

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Dissertation Committee:
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DEDICATION

To

my parents,

for letting me chase my dreams and follow my heart to California,

and for teaching me to believe in myself.

To

my husband,

for boundlessly supporting me,

and for following me into the dark,

to always pull me out into the light.

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ACKNOWLEDGMENTS

I thank my best friend, my husband, my partner in life a million times over. Muntasir, you have stood by my side from the very beginning, held my hand to pull me up every time I fell down, and celebrated every step forward, no matter how big or small. When I left Texas, a voice inside me constantly told me there was something beautiful waiting for me in California, and that, my love, was you. You were my adventure, and you soon became my family and my home. To emotionally and mentally support me through this stage of my life, all during the first three years of our marriage, is a feat deserving of a medal. This accomplishment is just as much mine as it is yours, because I would not have survived it without your support, your love, and all of the ice cream you got for me.

I am grateful to my parents for always encouraging me to make big goals for myself and empowering me with the confidence to achieve them. Their support in helping me reach my dreams has been boundless, despite the fact that it was difficult for them to come to terms that those very dreams would take me far from home. As I grew to have two homes—one in Texas and one in California—my Texas home became my sanctuary and escape from the challenges of graduate school, and I cherished the time I spent with my family in ways I had never appreciated before. I thank my parents for the gifts I have inherited from them: I have Mom's perseverance, which made me work the hardest I possibly could and vow to never give up even when every part of me wanted to. I have Papa's optimism, which allowed me to always see life as an adventure. With my whole heart, I thank you for everything you have done to help me achieve my dreams.

My sister, Sabrina, and my brother, Ammar, have been my constant source of warmth and comfort, for my whole life, but especially so in these last few years. So much has happened in this last era of each of our lives, and you have made sure that I never felt too far away—celebrating the joys of our marriages, experiencing the wonderment of our growing family, and marveling at all of our achievements. I could always count on Sabrina to help me come up with a good idea, find a better word to use, and to see the best side of every situation. I will always cherish the time Ammar spent with me every summer, dramatically telling me funny stories in a special way only he can. You both know my soul inside and out.

My niece, sweet baby Amira, born some time during the middle of this journey, brightened my world by infinite lumens and warms my heart with every cuddle and giggle. With her desire to only wear shirts with cats on them and numerous catchphrases, this little comedian often helped me regain a much-needed healthy dose of perspective. Until you were born into my world, I never knew the purest joy I could feel would be from being your Khala.

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I thank the National Science Foundation Graduate Research Fellowship Program for their contribution to my graduate education.

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Tarana **Khan** and Jacquelynne Eccles. (in preparation). "The Influence of Course-Specific Mindsets on Undergraduate Performance Attributions in a Challenging Course."

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RESEARCH EXPERIENCE

2018-2019 Project Assistant
EVALCORP Research & Consulting (Irvine, CA)
Consulting firm specializing in program evaluation, needs assessment, and strategic planning consulting services. Primary clients include government agencies, community-based non-profits, and schools.

- Analyzed and interpreted large quantitative datasets using advanced statistical analysis techniques in SPSS.
- Lead analyses of program effectiveness and prepare thorough reports to share findings with stakeholders.
- Collected and analyzed interview and focus group data through thematic coding schemes; conducted literature reviews; developed surveys.

2017-2019 Lead Researcher, P.I. Jacquelynne S. Eccles
Early College Motivation Project (UC Irvine)
Ten-month longitudinal study that surveyed undergraduates through online surveys to examine the impacts of course-related expectancies, values, mindset beliefs, and causal performance attributions on academic motivation and achievement during the early years of college.

- Conducted quantitative analysis of survey data and institutional data to explore intra-individual differences and stability of beliefs.
- Designed surveys on Qualtrics, recruited participants, and implemented data collection.
- Analyzed longitudinal data to examine how students' growth mindsets and causal attributions related to changes in student motivation and course achievement.
- Drafted manuscripts and prepared findings for presentations at conferences and in journal publications.

2014-2017 Graduate Student Researcher, P.I. Jacquelynne S. Eccles
Achievement Research Lab (UC Irvine)
NSF-funded project examining longitudinal datasets to investigate the impact of changes in the classroom and family environment on the development of student achievement beliefs, STEM-related career aspirations, and career choices.

- Prepared and analyzed data from the Michigan Study of Adolescent Life Transitions dataset.

- Analyzed longitudinal data to assess how adolescents' beliefs regarding their successes and failures in math related to changes in their math achievement and motivation.
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2013-2014 Research Assistant
MediaScience (Austin, TX)
Private media research lab exploring audience and consumer trends in multiple platforms including mobile apps, video games, wearable technology, trending TV shows, and television broadcast.

- Ran 30+ multi-platform qualitative and quantitative research projects with a panel of 25,000+ members.
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TEACHING EXPERIENCE

2014-2018 Teaching Assistant (UC Irvine)
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COMMUNITY SERVICE

2017-2018 Leadership Coach
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ABSTRACT OF THE DISSERTATION

Bridging Mindset Theory and Attribution Theory: A Longitudinal Exploration of Students' Belief Patterns in Their Early Years of College

By

Tarana Khan

Doctor of Philosophy in Education

University of California, Irvine, 2019

Professor Jacquelynne S. Eccles, Chair

I explored the interrelation of students' general intelligence mindsets, context-specific mindsets, and attributions in the early years of college. Dweck and her colleagues have proposed that a set of beliefs, called mindsets, regarding the malleability of one's intelligence and other characteristics, play a key role in how we respond to academic difficulties and failures. Mindsets have typically been understood as two separate worldviews—you can either have a growth mindset or a fixed mindset. However, there is a lesser explored possibility that students may endorse a mixture of both mindsets. Although Dweck has suggested that it is indeed possible for individuals to adjust their mindsets, mindsets have typically been thought of as stable traits, but there is little empirical support for whether this is true. Furthermore, little is known about how general mindsets compare to domain or context-specific mindsets. Past research has shown that specific attributions moderate the relationship between general mindsets and many achievement-related outcomes, but it is unclear how context-specific mindsets are related to context-specific attributions. Most studies have taken variable centered approaches to understanding how single attributions and one type of mindset impact achievement and motivation, but this is a limited story.

In the first study of this dissertation, I explored the stability and development of mindset beliefs over an academic quarter in two different academic contexts (hardest and easiest course). I also created homogenous subgroups of individuals who hold similar general and course-specific growth mindset and fixed mindset patterns and looked at how these patterns develop over time. In the second study, I utilized examined how context-specific growth and fixed mindsets were related to students' effort and ability attributions, respectively, in a challenging course context. In the third study, I used cluster analysis to find homogenous groups of students with similar mindsets and attribution patterns, exploring how these patterns were associated with academic performance indicators and students' motivation-related beliefs. The results of these studies have implications for understanding how college students' mindsets and attributions develop and change in differing academic contexts during the early years of college.
Keywords: growth mindset, fixed mindset, attribution theory, pattern-centered approaches

Introduction

How do the beliefs that we hold about our intelligence and abilities shape how successful we are? Why do some people give up in the face of difficulties or failure and others persist? Over the last 60 years, many scholars have tried to answer these questions, including both traditional causal attribution theory (ala Weiner, 1986) and more recently, mindset theory (ala Dweck, 2000). Current research suggests that the particular mindset one holds leads to a system of beliefs, which includes attributions, that individuals use to understand the causes of their academic successes and failures. Both of these theoretical perspectives link motivation and persistence in academic tasks to the causal explanations people make for their academic successes and failures, arguing that attributing one's difficulties on academic tasks to lack of a stable and uncontrollable characteristic like fixed ability would be more demotivating than attributing these difficulties to a more controllable characteristic such as lack of sufficient effort.

Given that the United States ranks poorly in students' educational achievement among our global peers, researchers have sought to come up with effective ways to close the race, gender, and social class achievement gaps. Studies have shown that students' academic mindsets play a critical role in educational achievement and some have suggested that targeting these mindsets at the policy level may be an effective way to close these achievement gaps (Rattan, Good, & Dweck, 2012). Growth mindsets have been taught in school (Blackwell, Trzesniewski, & Dweck, 2007) and online (Paunesku et al., 2015) programs. Growth mindset training has improved grades in middle school students, enhanced student persistence in online math games (O'Rourke, Haimovitz, Ballweber, Dweck, & Popovic, 2014), improved college students' year-end GPAs (Aronson, Fried, & Good., 2002), and improved high school students' GPAs in large-scale online interventions (Paunesku et al., 2015; Yeager et al., 2016). These findings have been

replicated in high school, community college and universities across the United States with students who have received one or two online mindset training sessions. However, we don't yet know how sustainable the results of these trainings are. Will they make a long-term impact because they are truly targeting beliefs that are stable? Or will these effects be as transient as perhaps the students' mindset itself? Although extensive research has indicated that fostering a growth mindset can improve students' motivation and raise grades, especially for struggling students, I argue that there is still a lot that we do not know about mindsets and that perhaps we should take a step back and try to understand the developmental roots of mindsets. How do our mindsets change and develop during critical life transitions? Do we reevaluate our beliefs about the malleability intelligence when faced with challenges? Are mindsets perhaps more trait-like than state-like? How do mindsets relate to our beliefs about our successes and failures? Can we endorse mixtures of mindsets? Do we have different mindsets for different aspects of our life? Through my dissertation, I aim to shed light on these questions.

Mindsets have typically been understood as two separate worldviews—you can either have a growth mindset or a fixed mindset. However, there is a lesser explored possibility that students may endorse a mixture of both mindsets. What also remains relatively less understood are the nuances of individuals' beliefs about the malleability of intelligence in general versus their own intelligence versus their own intelligence in specific domains or subjects. Furthermore, there is little research that delves into the stability and development of mindset beliefs over time, especially during critical periods such as the transition from high school to college. Interventions derived from both mindset theory and attribution theory have shown the power of getting students to focus on effort-based attributions for academic difficulties in facilitating the motivation to keep trying even when experiencing academic difficulties. However, little is

known about the long-term adaptive consequences of such interventions, perhaps because of the lack of research on how mindsets develop and change over time.

Weiner's attribution theory suggests that the causal factors that students use to interpret their performance in a course may influence their motivation and performance. Most studies have taken variable centered approaches to understanding how single attributions impact achievement and motivation, but because students likely endorse multiple types of attributions when understanding the causes for their academic performance, such a combination of effort attributions and ability attributions. Similar to exploring individuals' mixtures of mindsets, it is essential to understand how individuals' multiple attributions work together in different ways. Furthermore, past research has shown that specific attributions moderate the relationship between general mindsets and many achievement-related outcomes, but it is unclear how context-specific mindsets are related to context-specific attributions. Given that mindsets and attributions have been understood as significant determinants of the learning process, performance, and motivation in the classroom, more research is needed into which outcomes are actually influenced by specific mindsets beliefs. This dissertation also examines the relationship between mindsets and causal performance attributions as a possible route of influence through which mindsets may impact student learning.

In this dissertation, I will explore the possible mixtures of students' growth mindset and fixed mindset and the possible patterns of multiple attributions. I propose that individuals' beliefs about the malleability of intelligence in general may function and develop differently than the mindsets they hold about their own intelligence. I suggest that individuals' mindsets may differ across domains and academic contexts and that these beliefs may also differ from their general mindsets. These mindsets are likely to change in the early years of college given that challenging

academic contexts may cause students to repeatedly reevaluate their beliefs about their intelligence, especially in specific subject domains. I will also explore how students' effort and ability attributions about their performance in their courses are related to their course-specific mindsets regarding their intelligence in a challenging context.

Theoretical Framework

This dissertation aims to bridge together two seminal perspectives on how students understand the malleability of their intelligence and the causal explanations of their academic performance. In her mindset theory, Dweck and her associates (Dweck et al., 1995a; Dweck & Leggett, 1988) argued that people's implicit theories about themselves guide them to partake in certain behaviors and cause them to make certain causal attributions about their academic successes and failures. More specifically, she proposed two types of implicit theories — incremental theory (a growth mindset) and entity theory (a fixed mindset). Past research has shown that one's academic mindset predicts one's causal attributions for academic successes and failures (Hong et al, 1999; MacGyvers, 1992; Stipek & Gralinski, 1996). Thus, it is possible that mindsets influence academic persistence through their impact on causal attributions.

Having a growth mindset for intelligence means that an individual sees intelligence as something they can cultivate through effort and learning; thus, they would attribute their successes and failures alike to their effort and would be likely to persist in trying to master the challenging material as long as they value it (Dweck, 2000). Past research has heralded the growth mindset as the most adaptive and successful mindset (Blackwell et al., 2007; Dweck, 2000; Henderson & Dweck, 1990,), with Dweck encouraging students, parents, and teachers to take on a growth mindset in a myriad of life's domains (Dweck, 2007). Students with a growth mindset focus on learning leading to great academic achievement compared to students with

fixed mindsets (Yeager & Dweck, 2012). Previous studies have shown that students with a growth mindset have a higher level of determination (Blackwell et al., 2007; Stipek & Gralinski, 1996), which when coupled with a greater focus on learning, may lead to decrease in the rate of decline in achievement. Students with a growth mindset are more confident in their ability to change their future academic outcomes through studying or increased efforts compared to students with a fixed mindset; therefore, they are more likely to take measures to learn the information needed to do well (Mueller & Dweck, 1998; Plaks & Stecher, 2007).

Having a fixed mindset for intelligence means that an individual sees their intelligence as reflecting a fixed amount of talent that is immutable, thus they attribute their negative academic outcomes to lack of talent, and they do not think they can do much to alter their fixed amount of intellectual aptitude (Dweck, 2000). Such an attribution will lead to low expectations for future success, self-doubt, and giving up in the face of failure (Dweck, 2000; Plaks & Stecher, 2007; Weiner, 1986). Past research has supported the negative consequences of a fixed mindset (Hong et al, 1999; Henderson & Dweck 1990; Dweck, 2000). Furthermore, Dweck (2000) urges parents to never praise children using "person" praise—that is, saying they are a good girl or a smart girl when they do well on a task—and to instead use "process" praise and celebrate the effort and learning process their child experienced. Advocates of mindset theory argue that focusing on stable factors such as intelligence or talent as the causes of performance lead people to become highly concerned with measuring and validating their intelligence, often to the detriment of learning. People interpret their setbacks as a reflection of their underlying incompetence and exhibit defensive or ineffective strategies in the face of challenges or threats to their intelligence (Blackwell et al., 2007; Dweck & Molden, 2017). Dweck and colleagues argue that students with attributions focused around their ability will end up viewing working hard as reflections of their

deficient ability. Students with a fixed mindset tend to excel as long as the information comes easily for them, but their achievement lessens when they are faced with academic challenges or setbacks (Mueller & Dweck, 1998).

According to Dweck's model of implicit theories (Dweck & Leggett, 1988) and attribution theory (Weiner, 1972), a person with a fixed mindset would understand the causes for their academic failures to be rooted in something unchangeable, causing them to think there is nothing they can do to increase their intelligence. This may eventually cause a decline in motivation-related beliefs, such as in subjective task value (the qualities of the task that increase the chances of choosing the task) and self-concept of ability, leading to the devaluing of the subject, a lessened belief that one is good at the subject, and an increase in believing that they cannot change their ability through effort (Dweck, 2000; Weiner, 1986; Henderson & Dweck, 1990; Wigfield & Eccles, 2002). On the other hand, students who endorse a growth mindset are less likely to doubt their ability to succeed in the face of failure and are more prepared to respond to failure with increased effort, which may be the reason they experience higher academic achievement (Henderson & Dweck, 1990), lending evidence to the protective quality of a growth mindset against declines in motivation-related beliefs and achievement. Thus, when students with a growth mindset are faced with challenges, they are more likely to believe they have the power to improve their abilities through increased effort, which may result in greater valuing of the subject when the positive associations with their success become associated with their strong efforts (Eccles et al., 1983). However, attributing success to stable factors may also be adaptive and lead to higher performance because these students will feel more pride in their successful accomplishments, increasing the likelihood that subsequent actions toward achievement will be initiated (Weiner, 1972, Eccles & Wigfield, 2002).

In his causal attribution theory, Weiner (1972) argued that achievement related causal attributions influence whether students persist or give up after academic failures (Weiner, 1986; Weiner & Kukla, 1970). Weiner identified ability, effort, task difficulty, and luck as the most important factors that affect achievement attributions. Furthermore, attributions are classified along three causal dimensions: locus of control (internal versus external), stability (stable versus unstable), and controllability (uncontrollable versus controllable) (Weiner, 1974). In the current study, we focus on two factors—ability and effort. Students with higher achievement and greater confidence in their abilities tend to attribute their successes to internal, stable, and uncontrollable factors such as ability and attribute their failures to internal, unstable, controllable factors such as effort (Weiner, 1974). Attributing failures to unstable factors such as effort allows the person to believe they have volitional control and can increase or decrease their effort on future occasions. In a similar vein, Dweck and her associates (Dweck et al., 1995a; Dweck & Leggett, 1988) champion effort-focused thinking and process-oriented learning. They argue that people's implicit theories about themselves guide them to partake in certain behaviors and cause them to make certain causal attributions about their academic successes and failures. Although mindset theory would champion the idea that effort is the primary determinant of success, attribution theory suggests that believing in both effort and talent may be the key to academic success, engagement, and motivation. In this dissertation, we argue that students who endorse a growth mindset and make effort attributions as well as ability attributions will experience the greatest psychological benefits of having a growth mindset because such students will feel more pride in their successful accomplishments and continue seeking ways to improve their performance because they have a strong belief in the power of their efforts to grow their intelligence in a given subject domain but also have confidence in their ability to succeed.

Data

In the fall of 2017, a total of 177 undergraduate students were recruited to join the nine-month longitudinal study entitled The Early College Motivation Project (ECMP). All three studies use data from the ECMP dataset. Participants were recruited after the lead researcher visited several undergraduate classes during Week 0-2 of fall quarter. Students were recruited from two biology courses and four education courses in order to recruit students with a variety of majors. Surveys were administered online three times during each quarter for one academic year. The lead researcher recruited 177 undergraduate students (75% female; 35% freshman; 65% sophomore) for the research panel. The participants agreed to be a part of the study and opted in to receive emails for surveys. Even if a participant did not complete all waves of the study, they continued receiving surveys for subsequent waves. During the fall quarter, Wave 1 occurred before participants' midterm exam (Week 3-5), Wave 2 occurred after participants' midterm exam (Week 7-9), and Wave 3 occurred after final exams during the holiday break following fall quarter. Participants had two to three weeks to complete each survey. They were compensated for each survey the day after survey was due. The study will continue for six more waves during the winter and spring quarters; however, this dissertation utilizes data only from the first three waves of the study. This is due to the greatest number of students participating in the beginning waves of the study. 92% of participants completed Wave 1, 89% completed Wave 2, and 80% completed Wave 3.

The lead researcher visited classes to give a brief presentation about the study to recruit interested freshmen and sophomores. The lead researcher visited two classes in the Biological Sciences department (n=618) and three classes in the Education department (n=355) in order to recruit students with varied majors. The biological sciences classes were non-major courses that

are open to anyone at UCI. Two of the education courses were major requirements for education science majors and one was an elective. Students listened to a brief presentation about an overview of the study, eligibility requirements, and compensation. The total number of enrolled students in the five classes was approximately 973 students. Of the 973 students who were presented with the opportunity to join the study, 336 students expressed interest in the study. Interested students signed up on a sign-up sheet and were contacted within a few days with a recruitment survey that allowed them to read the consent form and consent to joining the study. 177 students of the 183 students who completed the recruitment survey were eligible for the study (e.g., they were freshman or sophomores and above age 18), yielding a total recruitment rate of 18%. In the final sample, 48.6% students were recruited from Bio Sci 35: Brain and Behavior, 29.9% were recruited from Bio Sci 36: Drugs and the Brain, 14.1% students were recruited from Education 50: Issues in K-12 Education, 6.8% were recruited from Education 10: Research Design, and 0.6% were recruited from Education 55: Knowledge and Learning in Math and Science. Students received a personalized link to their first survey during Week 3 of the fall quarter. Students were automatically reminded via email to complete the survey if they had not completed it within seven, ten, and thirteen days of the allotted two-week period. All subsequent surveys were sent via personalized link to students every 3 to 4 weeks.

Overview of Studies

Study 1: A Tale of Two Types of Mindsets in Two Different Course Contexts: The Development of General and Course-Specific Fixed and Growth Mindsets in the Early Years of College. Study 1 used a variable-centered and pattern-centered approach to explore the stability of general mindset beliefs and context-specific mindset beliefs in two different academic contexts over the course of a quarter. Students' self-reported most difficult class and easiest class

will be used as the two different contexts in order to explore how mindset beliefs may differ across domains. After using a variable-centered approach to explore the stability of the three types of mindset beliefs over the course of an academic quarter, I used a pattern-centered approach to create homogenous subgroups of individuals who hold similar general and course-specific growth mindset and fixed mindset patterns and look at how these patterns develop from the beginning to the end of the academic quarter. Patterns were explored for individual stability (whether students stay in the same mindset pattern over time) and structural stability (how the structure of the patterns change over time). Study 1 has three research aims: *Exploring the stability of four types of mindsets: general growth mindset, general fixed mindset, course specific growth mindset, and course specific fixed mindset over the course of an academic quarter; Exploring the individual and structural stability of students' general growth mindset patterns, general fixed mindset patterns, course specific growth mindset patterns, and course specific fixed mindset patterns over the course of an academic quarter*; and *Exploring how the stability of these mindset patterns may differ in an easy and difficult context.* Findings from these research aims suggest that students have several different ways of endorsing their growth and fixed mindset beliefs. Findings also revealed that there is considerable individual stability in general and hardest/easiest course-specific mindsets, indicating that students may not differentiate in their development of these types of mindset beliefs over time.

Study 2: The Influence of Course-Specific Mindsets on Undergraduate Performance Attributions in a Challenging Course. Study 2 examines one possible route of influence through which mindsets may impact student learning: the relationship between course-specific growth and fixed mindsets to students' effort and ability attributions. The second study explores how course-specific attributions for students in challenging course context develop between

students' midterm and final exam, the relationship between course-specific attributions and course-specific mindsets, and how this relationship is influenced by students' perceptions of their performance in their hardest course. The first research question is, *To what extent do effort causal attributions change over the course of a quarter? If they do change, is this change related to initial growth mindset beliefs?* The second research question is, *To what extent does having a growth mindset lead to stronger effort causal attributions in a challenging course context?* The third research question is, *To what extent do ability causal attributions change over the course of a quarter? If they do change, is this change related to a fixed mindset?* The fourth research question is, *To what extent does having a fixed mindset lead to stronger ability attributions in a challenging context?* The fifth research question is, *To what extent is the perception of whether one has done well in their courses associated with students' mindsets and attributions*? Findings indicated that the effort and ability attributions students made in a challenging course context remained the same from mid-quarter to post-quarter, students with strong course-specific growth mindsets were not more likely to make more effort attributions for their midterm and final exams, and stronger fixed mindset beliefs were marginally statistically significantly related to weaker effort attributions at mid-quarter.

Study 3: A Pattern Centered Approach to Undergraduates' Mindsets and Performance Attributions: Rethinking the effort-championed motives of the growth mindset. Although mindset theory champions the idea that effort is the primary determinant of success, the present study takes a different approach to illustrate that perhaps believing in both effort and talent are the keys to academic success, engagement, and motivation. The types of causal performance attributions a student endorses may have a differential impact on motivation and achievement for college students depending on the type of mindset they hold. We created

homogenous subgroups of individuals who have similar belief networks of course-specific mindsets, effort attributions, and ability attributions, and explored the extent to which these patterns are associated with students' motivation-related beliefs regarding their courses (e.g., self-concept of ability and subjective task value) and course grades, overall GPA, and performance perceptions at two time points in the academic quarter (mid-quarter and post-quarter). The first research purpose is to *identify growth/fixed mindset and effort/ ability causal performance attribution patterns for undergraduate students during two time points in an academic quarter (mid-quarter and post-quarter).* The second research purpose is to *investigate the extent to which academic performance indicators (course performance and GPA) and motivation-related beliefs differ between a) individuals who have strong growth mindset beliefs, strong fixed mindset beliefs, or balanced mindset beliefs and b) individuals who endorse a growth mindset and only endorse effort performance attributions versus individuals who endorse a growth mindset and both effort and ability performance attributions.* The third research purpose is to *investigate the extent to which endorsing effort causal performance attributions protect students who have a fixed mindset from possible low academic performance and motivation-related beliefs that are typically associated with having a fixed mindset.* Findings from these research purposes indicated that students who strongly endorsed a growth mindset as well as strong effort and ability attributions had stronger subjective task value (attainment value, utility value, and intrinsic value) and self-concept of ability for their hardest course compared with students who had stronger fixed mindset beliefs coupled with moderate effort and ability attributions and students who had more moderate growth and fixed mindset views coupled with lower effort and ability attributions. Students with a growth mindset did not differ on any academic performance indicators compared with students who had a fixed mindset or balanced

mindset pattern. Results suggest that even though the groups did not differ in their academic achievement, the attributions students endorse in conjunction with their mindsets may be an important component of a network of beliefs that students use to understand their academic identity and values.

Significance

There is extensive literature and research that mindsets and attributions are important determinants of students' academic motivation, interest in their courses, and academic achievement. However, little is known about how individuals may have a mixture of fixed mindset and growth mindset beliefs and how these beliefs align with multiple types of attributions. Furthermore, given that mindsets have typically been thought of stable traits, it has seldom been explored how mindset beliefs may develop and change over time, especially during critical periods such as the transition from high school to college. Little attention has been given to the fact that an individual's belief about the malleability of intelligence in general may be different than their beliefs about their own intelligence. Furthermore, students' beliefs about their intelligence may be specific and unique to different domains. Little is known about how these unique context-specific beliefs may develop and change in more dynamic and different ways than general mindsets over time. Most studies have taken variable-centered approaches to study both mindsets and attributions, but I suggest that a pattern-centered approach may also be necessary in order to understand how these beliefs coexist in important ways. Individual differences lead to differences in achievement; thus, a pattern-centered approach lends itself to looking at how individuals differ in their endorsement of multiple types of beliefs. Attribution theory and mindset theory have been extensively studied separately, and although some studies have explored the relationship between the two belief systems, I argue in this dissertation that the

beliefs regarding the malleability of their intelligence are very closely linked to the causal explanations students make for their academic performance, and that it is necessary to understand how these beliefs develop in critical academic situations such as the early years of college. Interventions derived from both attribution perspectives and mindset theory have successfully altered students' beliefs, but the long-term adaptiveness of such interventions is unclear. Furthermore, while the popularity of mindset interventions has soared (Paunesku et al., 2015; Yeager, Romero et al., 2016; Yeager, Walton et al., 2016), with many school settings readily paying thousands of dollars to implement mindset interventions into their curriculum, many studies have failed to replicate the success of the original mindset studies that claimed teaching students to have a growth mindset resulted in higher grades. However, recent findings that mindset beliefs have no relationship with academic outcomes and that mindset interventions have no impact on increasing achievement scores (Bahnik & Vranka, 2017; Education Endowment Foundation, 2018; Sisk et al., 2018), cast a shadow of skepticism over the real impacts of mindsets. It is becoming more and more unclear whether attempts to change students' mindsets about their abilities and intelligence have any positive effect on their learning at all (Hendrick, 2019). If we are able to understand how these beliefs are formed and develop over time, we may be able to create interventions that target beliefs in more nuanced and specific ways by taking into consideration the factors that may alter individuals' mindsets and attribution networks. A better understanding of how students' mindsets and attribution patterns impact their course-related motivation may have implications for how professors and instructors may optimize student engagement during the early years of college.

References

Aronson, J., Fried, C., & Good, C. (2002). Reducing the effects of stereo- type threat on African American college students by shaping theories of intelligence. Journal of Experimental Social Psychology, 38, 113–125. http://dx.doi.org/10.1006/jesp.2001.1491

Bahník, S., Vranka M.S. (2017). Growth mindset is not associated with scholastic aptitude in a large sample of university applicants. *Personality and Individual Differences, 117*, 139–143

Blackwell, K. L., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*(1), 246–263. doi:10.1111/j.1467-8624.2007.00995.x

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. New York, NY: Psychology Press.

Dweck, C. S. (2007). *Mindset: The new psychology of success*. New York, NY: Ballantine Books.

Dweck, C. S., Chiu, C. & Hong, Y. (1995a). Implicit theories and their role in judgments and reactions: A world from two perspectives. *Psychological Inquiry, 6*, 267-285. doi: 10.1207/s15327965pli0604_12

Dweck, C. S., & Leggett, E. L. (1988). A social cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256–273. doi:10.1037/0033-295X.95.2.256

Dweck, C. S., & Molden, D. C. (2017). Mindsets: Their impact on competence motivation and acquisition. In A.J. Elliot, C.S. Dweck, & D.S. Yeager (Eds,), *Handbook of competence and motivation, Second Edition, Theory and Application* (135-154). New York, NY: Guilford Publications.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., et al. (1983). Expectancies, values and academic behaviors. In J. T. Spencer (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 75-146). San Francisco: W. H. Freeman.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53,* 109-132.

Education Endowment Foundation. (2018). Changing mindsets. What Works Centre for Education.

Henderson, V. L., & Dweck, C. S. (1990). Achievement and motivation in adolescence: A new model and data. In S. Feldman & G. Elliott (Eds.) *At the threshold: The developing adolescent*. Cambridge, MA: Harvard University Press.

Hendrick, C. (2019). The growth mindset problem. *AEON*.

Hong, Y., Chiu, C., Dweck, C. S., Lin, D. M., & Wan, W. (1999). Implicit theories, attributions, and coping: A meaning system approach. *Journal of Personality and Social Psychology*, *77*(3), 588-599. doi:10.1037/0022- 3514.77.3.588

MacGyvers, V. (1992). Implicit theories and real-world outcomes. Unpublished doctoral thesis, University of Illinois at Urbana-Champaign.

Mueller, C.M., & Dweck, C.S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology, 75*, 33–52.

O'Rourke, E., Haimovitz, K., Ballweber, C., Dweck, C. S., & Popovic, Z. (2014). Brain points: A growth mindset incentive structure boosts persistence in an educational game. In CHI '14: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 3339–3348). New York, NY: Association for Computing Machinery.

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015). Mind-set interventions are a scalable treatment for academic underachievement. Psychological Science, 26, 784–793. http://dx.doi.org/10.1177/0956797615571017

Plaks, J. E., & Stecher, K. (2007). Unexpected improvement, decline, and stasis: A prediction confidence perspective on achievement success and failure. *Journal of Personality and Social Psychology, 93*(4), 667–684.

Rattan, A., Good, C., & Dweck, C. S. (2012). It's ok – not everyone can be good at math: Instructors with an entity theory comfort (and demotivate) students. Journal of Experimental Social Psychology, 48(3), 731–737. doi:10.1016/j.jesp.2011 .12.012.

Sisk, V.F., Burgoyne, A.P., Sun, J., Butler, J.L., Macnamara, B.N. (2018). To what extent and under which circumstances are growth mindsets important to academic achievement? Two meta-analyses. *Psychological Science*, *29*(4), 549-571.

Stipek, D., & Gralinski, J. H. (1996). Children's beliefs about intelligence and school performance. *Journal of Educational Psychology*, 88, 397- 407. doi:10.1037/0022-0663.88.3.397

Weiner, B. (1972). Achievement attribution and the educational process. *Review of Educational Research*, *42*(2), 203–215. doi:10.2307/1170017

Weiner, B. (1986). *An attributional theory of motivation and emotion*. New York: Springer-Verlag.

Weiner, B., & Kukla, A. (1970). An attributional analysis of achievement motivation. *Journal of Personality and Social Psychology*, 15, 1-20. doi: 10.1037/h0029211

Wigfield, A., & Eccles, J. S. (2002). Children's motivation during the middle school years. In J. Aronson (Ed.), *Improving academic achievement: Contributions of social psychology*.

San Diego, CA: Academic Press.

Yeager, D.S. & Dweck, C.S. (2012) Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist, 47*(4), 302-314, DOI: 10.1080/00461520.2012.722805

Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., . . . Dweck, C. S. (2016). Using design thinking to improve psychological interventions: The case of the growth mindset during the transition to high school. Journal of Educational Psychology, 108, 374-391. doi:10.1037/edu0000098

Chapter 1: A Tale of Two Types of Mindsets in Two Different Course Contexts: The Development of General and Course-Specific Fixed and Growth Mindsets in the Early Years of College

Abstract

Dweck and her colleagues have proposed that a set of beliefs, called mindsets, regarding the malleability of one's intelligence and other characteristics, play a key role in how we respond to academic difficulties and failures. Mindsets have typically been understood as two separate worldviews—you can either have a growth mindset or a fixed mindset. However, there is a lesser explored possibility that students may endorse a mixture of both mindsets. Although Dweck has suggested that it is indeed possible for individuals to adjust their mindsets, mindsets have typically been thought of as stable traits, but there is little empirical support for whether this is true. Furthermore, little is known about how general mindsets compare to domain or context-specific mindsets. The present study explores the stability and development of mindset beliefs over an academic quarter through complementary variable-centered and pattern-centered analysis. The results of these approaches suggest that there is considerable individual stability in general and course-specific mindsets, indicating that students may not differentiate in their development of these types of mindset beliefs over time. Students who had moderate to strong growth mindset beliefs tended to maintain their beliefs over time and students who started off with strong fixed mindsets tended to weaken their beliefs over time. Students who had less extreme mindsets tended to either remain steady in their beliefs or shifted to stronger fixed mindset views. Results have implications for understanding how college students' mindsets develop in differing academic contexts during the early years of college.

Keywords: theories of intelligence, growth mindset, fixed mindset, pattern-centered approaches, undergraduate academic motivation

A Tale of Two Types of Mindsets in Two Different Course Contexts: The Development of General and Course-Specific Fixed and Growth Mindsets in the Early Years of College

Dweck has suggested that it is possible for people to hold multiple types of mindsets (Dweck, 2015), but there has been little empirical support for this idea. Respondents have been mostly treated as existing on one pole or the other of the mindset continuum, masking the possibility of mixtures of a fixed mindset and growth mindset. It also remains relatively unexplored how individuals' beliefs about the malleability of intelligence in general compares to beliefs about their own intelligence and their own intelligence across different domains. There is also little research that looks at the stability and development and mindset beliefs over time, especially during critical transition periods such as the early years of college. When a bi-dimensional approach to the mindset scale has been utilized, findings show that over time there is a negative reciprocal relationship between growth mindset and fixed mindsets (Martin, 2015), indicating that individuals may coordinate their growth and fixed mindset beliefs in dynamic ways that have been largely unexplored. I use a variable-centered and pattern-centered approach to explore the stability of two different types of mindset beliefs in two different academic contexts over the course of a quarter. I explore how general beliefs about the malleability of intelligence and course-specific beliefs about the malleability of intelligence in the students' self-reported easiest and most challenging courses change over an academic quarter. Specifically, I look at whether course-specific mindset beliefs are likely to change to a greater extent than general mindset beliefs because they will be most impacted by the experiences in the course.

Literature Review

Dweck's Mindset Theory

In her mindset theory, Dweck and her associates (Dweck et al., 1995a; Dweck & Leggett, 1988) argued that people's implicit theories about themselves guide them to partake in certain behaviors and cause them to make certain causal attributions about their academic successes and failures. More specifically, she proposed two types of implicit theories —incremental theory (a growth mindset) and entity theory (a fixed mindset). Having a growth mindset for intelligence means that an individual sees intelligence as something they can cultivate through effort and learning; thus, they would attribute their successes and failures alike to their effort and would be likely to persist in trying to master the challenging material as long as they value it (Dweck, 2000). Past research has heralded the growth mindset as the most adaptive and successful mindset (Blackwell et al., 2007; Dweck, 2000; Henderson & Dweck, 1990,), with Dweck encouraging students, parents, and teachers to take on a growth mindset in a myriad of life's domains (Dweck, 2007). Students with a growth mindset focus on learning leading to great academic achievement compared to students with fixed mindsets (Yeager & Dweck, 2012). Previous studies have shown that students with a growth mindset have a higher level of determination (Blackwell et al., 2007; Stipek & Gralinski, 1996), which when coupled with a greater focus on learning, may lead to decrease in the rate of decline in achievement. Students with a growth mindset are more confident in their ability to change their future academic outcomes through studying or increased efforts compared to students with a fixed mindset; therefore, they are more likely to take measures to learn the information needed to do well (Mueller & Dweck, 1998; Plaks & Stecher, 2007).

Students who endorse a growth mindset are less likely to doubt their ability to succeed in the face of failure and are more prepared to respond to failure with increased effort, which may be the reason they experience higher academic achievement (Henderson & Dweck, 1990), lending evidence to the protective quality of a growth mindset against declines in motivation-related beliefs and achievement. Thus, when students with a growth mindset are faced with challenges, they are more likely to believe they have the power to improve their abilities through increased effort, which may result in greater valuing of the subject when the positive associations with their success become associated with their strong efforts (Eccles et al., 1983). However, attributing success to stable factors may also be adaptive and lead to higher performance because these students will feel more pride in their successful accomplishments, increasing the likelihood that subsequent actions toward achievement will be initiated (Weiner, 1972, Eccles & Wigfield, 2002).

Having a fixed mindset for intelligence means that an individual sees their intelligence as reflecting a fixed amount of talent that is immutable and they do not think they can do much to alter their fixed amount of intellectual aptitude (Dweck, 2000). This type of belief system will lead to low expectations for future success, self-doubt, and giving up in the face of failure (Dweck, 2000; Plaks & Stecher, 2007; Weiner, 1986). Past research has supported the negative consequences of a fixed mindset (Hong et al, 1999; Henderson & Dweck 1990; Dweck, 2000). Furthermore, Dweck (2000) urges parents to never praise children using "person" praise—that is, saying they are a good girl or a smart girl when they do well on a task—and to instead use "process" praise and celebrate the effort and learning process their child experienced. Advocates of mindset theory argue that focusing on stable factors such as intelligence or talent as the causes of performance lead people to become highly concerned with measuring and validating their

intelligence, often to the detriment of learning. People interpret their setbacks as a reflection of their underlying incompetence and exhibit defensive or ineffective strategies in the face of challenges or threats to their intelligence (Blackwell et al., 2007; Dweck & Molden, 2017). Dweck and colleagues argue that students with attributions focused around their ability will end up viewing working hard as reflections of their deficient ability. Students with a fixed mindset tend to excel as long as the information comes easily for them, but their achievement lessens when they are faced with academic challenges or setbacks (Mueller & Dweck, 1998).

A person with a fixed mindset would understand the causes for their academic failures to be rooted in something unchangeable, causing them to think there is nothing they can do to increase their intelligence. This may eventually cause a decline in motivation-related beliefs, such as in subjective task value (the qualities of the task that increase the chances of choosing the task) and self-concept of ability, leading to the devaluing of the subject, a lessened belief that one is good at the subject, and an increase in believing that they cannot change their ability through effort (Dweck, 2000; Weiner, 1986; Henderson & Dweck, 1990; Wigfield & Eccles, 2002).

A Longitudinal Look at the Stability of Mindset Beliefs

Little research has been devoted to understanding how mindsets may develop and change over time. Most of the previous studies on mindset theories have utilized cross-sectional approaches. The longitudinal studies regarding mindset (Blackwell et al., 2007; Romero et al., 2014) did not simultaneously measure mindset and the outcomes they predicted. The most common approach was to measure mindset at a prior time point and then to measure the outcomes at a later time point. However, when the prior level of an outcome is not statistically controlled for, the evidence of prospective effects is confounded by the concurrent relation between the constructs, possibly leading to inaccurate estimates of prospective effects (Cole &

Maxwell, 2003). King (2017) argues that studies using the mindset scale should include measures of mindset and outcomes across at least two time points to obtain valuable information that would otherwise be missed in cross-sectional research. In the present study, two time points of mindset beliefs will be assessed.

Past research has seldom tested the possibility of reciprocal effects (for exceptions, see Martin, 2015 and King, 2017) and have instead focused on the causal role of mindset on key learning outcomes such as academic achievement, self-regulation, motivation, and engagement (Burnette et al., 2013; Dinger & Dickhauser, 2013). Experimental studies have manipulated students' implicit theories and measured the effects of these experimental manipulations or interventions on these learning outcomes. I, among others (King, 2017; Martin, 2015), argue that the relationship between implicit theories and outcomes is likely to be dynamic, especially over time. Although Dweck has suggested that it is indeed possible for individuals to adjust their mindsets, mindsets have typically been thought of as stable traits, but there is little empirical support for whether this is true. For example, it is possible that the mindset a student endorses may influence how much she values her biology course, and in turn her value for biology may have an impact on her mindset. She may endorse a growth mindset which causes her to put forth consistent effort, even in the face of increasingly challenging material. Across the academic quarter, her strong efforts may be met with high grades, reinforcing her value for biology and confirming her belief that if she tries hard enough, she can increase her intelligence in biology. On the other hand, another student may initially endorse a growth mindset, but after studying relentlessly for an exam and unable to pass the course, his confidence falters and he begins to believe that no matter how hard he works, he cannot do well in biology, and begins to endorse a fixed mindset. With most previous studies in this area, the research was not longitudinal and so it

could not be established whether mindsets predict an outcome variable such as motivation, goal orientation, or achievement beyond prior variance in the specified outcome. Thus, experimental and longitudinal studies that do not explicitly measure mindset across two or more points in time are unable to ascertain whether the relationship between mindsets and outcomes are dynamic and reciprocal.

Research on intelligence mindsets have treated intelligence as a trait-like attribute, such that the belief one holds about their intelligence, whether malleable or fixed, is stable and generally applicable to many domains. Although it has typically been suggested that mindsets are stable, trait-like characteristics, there is an inconsistency in this argument because many of the interventions and trainings are designed to and, in fact, do change mindset beliefs. Moreover, Dweck (2007, 2010) has suggested that implicit theories are not immutable and that it is indeed possible for individuals to adjust their beliefs about their intelligence and how it develops. Little attention has been given to what factors may alter an individual's mindset. Shively and Ryan (2013) found that college students' growth mindset beliefs surrounding their intelligence in math became weaker over the course of a semester in college algebra. I argue that individuals undergoing drastic life transitions, such as entering college, may suddenly and repeatedly reevaluate their beliefs about their intelligence, especially when confronted with new styles of instruction and challenging material (Henderson & Dweck, 1990). During major transitions, preexisting knowledge and beliefs guide the way individuals perceive and respond to their environment, which becomes especially true for students entering college and often moving away from home for the first time. Many students face new personal and academic challenges and are forced to learn how to cope with multiple demands on their time, energy, and emotions (Cantor, Norem, Niedenthal, Langston, & Brower, 1987). Thus, their beliefs about whether their

intelligence is malleable or fixed may be more transient and state-like depending on their courses and the feedback they receive from their grades and professors. It could be possible that contextual factors such as the difficulty of a course, negative feedback, poor grades, and repeated failing may alter one's mindset.

The extant literature has seldom explored how mindsets may change over a major life transition (for an exception, see Yeager et al., 2016). Robins and Pals (2002) conjectured that college achievement context may serve as a reactive person-environment interaction in which individuals react differently to the same environment depending on their traits, beliefs, and goals, such that the academic context simply reinforces individuals' beliefs about their intelligence and abilities. Thus, they found that the college environment produced no mean-level change mindsets and that mindsets were relatively stable over time. Robins and Pals (2002), however, did not measure mindsets longitudinally from high school to college; thus, mindsets may be less stable across developmental transition points. Furthermore, despite the lack of mean-level change and relative high stability, their results do not preclude the possibility of systematic change at the individual level. This dissertation aims to look at the individual level of change by taking a pattern-centered approach to mindset beliefs over time. I aim to fill this gap in the understanding of the stability of mindsets by assessing students' general and domain-specific beliefs at multiple time points across one academic quarter. I plan to look at a relatively unexplored idea that specific academic contexts, such as whether a student finds a course challenging or easy, may lead to changes in individuals' mindsets.

Possible Mixtures of Growth Mindset and Fixed Mindset

Recently, Dweck has suggested that it is possible for people to hold multiple types of mindsets (Dweck, 2015), but research has seldom explored this possibility. Moreover, the idea of

mixed mindsets is not consonant with the way it has been typically measured. Mindsets have usually been discussed and measured as a unidimensional construct of two opposite belief systems—you either have a growth mindset or a fixed mindset. Studies conducted primarily in the 1990s utilized a three-item scale that included only fixed mindset items (Dweck et al., 1995a; Hong et al., 1999, Levy et al., 1998). Those who scored an average score of four or more were categorized as having a fixed mindset and those who had an average of three or below were categorized as having a growth mindset. Those who scored between an average score of three and four were excluded. Individuals who have more moderate beliefs, or possibly mixed beliefs, are excluded. Additionally, such a measurement scale treats a fixed mindset and growth mindset as a dichotomous variable that assumes that disagreement with the fixed mindset scale means agreement with growth mindset ideas, which may not always be the case for all individuals.

More recent studies have measured mindsets as a continuous variable by utilizing a summative score on an 8-item scale that included fixed mindset items and reversed growth mindset items so that a low score on the scale indicates a fixed mindset and a high score indicates a growth mindset. This type of measurement is also problematic in that it assumes that a growth mindset is the opposite of a fixed mindset, which may be the case for those with extreme views, but not for those with more moderate views.

Although mindsets have typically been measured on a scale that varies on a continuum between two poles—the fixed mindset on one side and the growth mindset on the other side—respondents are largely treated as existing fully on one pole if they surpass or fall below the midpoint of the scale. Interestingly, the average score on these kinds of scales is well above the midpoint, illustrating that even a below average score would not indicate a fixed mindset. Thus, although it is measured on a continuum, mindset is rarely treated like the continuum that it in fact

represents and is instead operationalized as direct opposites and dichotomized from a unidimensional construct. Some research supports a bi-dimensional approach where growth mindset beliefs and fixed mindset beliefs are understood as correlated but distinct factors (Martin, 2015). Martin (2015) found that there was a negative reciprocal relationship between growth mindset beliefs and fixed mindset beliefs across the course of a year for high school students. Having a growth mindset in one year predicted reduced fixed mindset beliefs a year later, and fixed mindset beliefs in one year predicted reduced growth mindset beliefs a year later, implying that individuals may coordinate their growth and fixed mindset beliefs in important and dynamic ways that have been largely unexplored. In this dissertation, I take a pattern-centered approach to mindsets, so that the continuum becomes visible and the black and white camps of fixed mindset and growth mindset become more nuanced and reflective of the holistic theories an individual endorses about their intelligence. In this way, we may also disentangle how individuals coordinate their growth mindset beliefs and fixed mindset beliefs together over time.

Domain-Specificity of Mindsets

Dweck (2000) as suggested that people may hold views about the malleability of a variety of different traits, such as personality or morality in addition to intelligence. However, only a few studies have looked at how mindset regarding the malleability of intelligence differs across domains (see Burns & Isbell, 2007; McCutchen, Jones, Carbonneau, & Mueller, 2016). To my knowledge, only one study has explored how domain-specific mindsets compare to general mindsets (see Shively & Ryan, 2013). Shively and Ryan (2013) found that general mindsets were correlated with math mindsets, but that students' math mindsets were significantly more fixed than their general mindsets. Additionally, a larger discrepancy in general versus math-specific intelligence beliefs was negatively correlated with course performance, indicating

that the relationship between general and domain-specific mindsets may have important academic consequences. Shively and Ryan (2013) also argued that theories of math intelligence would be more likely than theories of general intelligence to change over the course of a semester. Because students were enrolled in math courses, their experiences in the courses seemed more likely to influence their beliefs about their math intelligence than their overall intelligence. Thus, because college students take a variety of courses in their early years of college to fulfill a wide breadth of degree requirements, mindset beliefs about intelligence may differ from course to course. Notably, Shively and Ryan (2013) found that a decrease in growth mindset beliefs over one year was greater for college students' math intelligence compared to their beliefs about their general intelligence, implying that beliefs about general versus domain-specific intelligence may develop in different ways. McCutchen et al. (2016) did not find that mindsets differed across the domains of math and reading. Students with a fixed mindset for math had a faster rate of decline in math achievement compared to students with a growth mindset, but there was no effect for reading. This may indicate that experiences in specific domains may impact students' achievement behaviors differently despite students having the same mindset about their intelligence in both domains. Prior research has only looked at students' mindset beliefs in the domains of math and reading.

It seems plausible that students' predispositions about their domain-specific intelligence would be more malleable than their predispositions about their general intelligence because their experiences within a specific domain may serve to shape their perceptions of their domain-specific intelligence. The original mindset scale was not domain-specific, and although a few studies have altered the scale to reflect domain-specificity (Burns & Isbell, 2007; McCutchen et al., 2016; Shively & Ryan, 2013), past research has seldom looked at the domain-specificity of

mindset beliefs, especially not in specific courses. This study aims to fill this methodological gap by contextualizing the original mindset scale by additionally measuring students' course-specific mindsets in their most difficult and easiest course over an academic quarter.

Summary

There is extensive literature and research that mindsets are an important determinant of students' academic motivation, interest in their courses, and academic achievement. However, little is known about how individuals may have a mixture of fixed mindset and growth mindset beliefs. Furthermore, given that mindsets have typically been thought of stable traits, it has seldom been explored how mindset beliefs may develop and change over time, especially during critical periods such as the transition from high school to college. Little attention has been given to the fact that an individual's belief about the malleability of intelligence in general may not align with their beliefs about their own intelligence. Furthermore, their beliefs about their intelligence may be specific and unique to different domains. Little is known about how these unique context-specific beliefs may develop and change in more dynamic and different ways than general mindsets over time. Interventions derived from mindset theory have successfully altered students' beliefs, but the long-term adaptiveness of such interventions is unclear. If we are able to understand how these beliefs are formed and develop over time, we may be able to create interventions that target beliefs in more nuanced and specific ways by taking into consideration the factors that may alter individuals' mindsets and attribution networks.

The Present Study

Most studies have taken variable-centered approaches to study mindsets, but I suggest that a pattern-centered approach may also be necessary in order to understand how these beliefs coexist in important ways. Individual differences lead to differences in achievement; thus, a

pattern-centered approach lends itself to looking at how individuals differ in their endorsement of multiple types of beliefs. After looking at students' growth mindset beliefs and fixed mindset beliefs separately in order to understand which types of beliefs are more susceptible to change over time, I use a pattern-centered approach to create homogenous subgroups of individuals who hold similar belief patterns across constructs and look at how these patterns develop over an academic quarter. Utilizing such an approach will allow an understanding of how mindset beliefs cohere together, be more reflective of the holistic theories an individual endorses about their intelligence, offer a more nuanced look at how a growth mindset and fixed mindset coexist in an individual, and illuminate how the dynamic between the two types of mindsets may lead to differing levels of stability. I take a developmental snapshot by looking at two points in the quarter and linking group membership over time, exploring these beliefs in two academic contexts—an easy course and a difficult course—in order to investigate the possibility that challenging situations, especially during crucial life transitions, may cause individuals to reevaluate and change their beliefs about their intelligence in a specific domain.

Research Aims

Three research aims are as follows:

1) Variable-centered approach: Exploring the stability of four types of mindsets: general growth mindset, general fixed mindset, course specific growth mindset, and course specific fixed mindset over the course of an academic quarter

2) Pattern-centered approach: Exploring the individual and structural stability of students' general mindset patterns and course specific mindset patterns over the course of an academic quarter

3) Exploring how the stability of these mindset patterns may differ in an easy and difficult context

Hypothesized Results

I hypothesize that students' general growth mindset and fixed mindset will be more stable than students' course-specific growth mindset and fixed mindset, overall. When students are confronted with new styles of instruction and challenging material, they may be likely to repeatedly reevaluate their beliefs about their intelligence, especially their domain-specific intelligence which is more likely to be influenced by their experiences in a given course (Cantor et al., 1987; Henderson & Dweck, 1990). I expect students' course-specific growth mindset beliefs may weaken in their most challenging course compared to their easiest course. Furthermore, although general and course-specific mindsets will most likely be correlated, students may have more fixed course-specific mindsets for their most challenging course compare to their easiest course. Also, fixed mindset beliefs may become stronger over time about students' most challenging courses compared to their easiest course. De Castella and Byrne (2015) found greater disengagement in courses where there was a greater discrepancy between general intelligence beliefs and personal intelligence beliefs, indicating that perhaps a greater discrepancy between these two kinds of beliefs may exist for more challenging academic contexts. According to Robins and Pals (2002), if general mindsets are indeed more trait-like than state-like, the college achievement context may serve as a reactive person-environment interaction that simply reinforces individuals' preexisting beliefs about intelligence and abilities.

Predicted patterns for general mindsets. Although there may be several possible patterns that emerge through the proposed analyses, I will discuss a few general patterns, based on past research and theoretical underpinnings, that I expect will emerge.

Growth mindset dominant pattern. A growth mindset dominant pattern would reflect a student who strongly believes their intelligence can be improved on and changed more than they believe it can't. This is not to say the student does not endorse a fixed mindset at all, but that they do to a lesser extent compared to their growth mindset. Within this general pattern, there may be sub-patterns such as a strongly dominant growth mindset pattern or a moderately dominant growth mindset pattern.

Fixed mindset dominant pattern. A fixed mindset dominant pattern would reflect a student who strongly believes their intelligence is not malleable more than they believe it can be changed. This student may also endorse some aspects of a growth mindset, but to a lesser extent. Within this general pattern, there may also exist similar sub-patterns as above.

Balanced pattern. A growth mindset and fixed mindset balanced pattern would reflect a student who endorses a fixed mindset and growth mindset to about the same extent. Within this general pattern, there are also possible sub-patterns. For example, a student may strongly endorse both mindsets, moderately endorse both, or endorse neither mindset.

Predicted patterns for course-specific mindsets. There may be several possible course-specific mindset patterns and sub-patterns that emerge. I will discuss a few general patterns that I expect will emerge. I will discuss how these patterns may differ for the students' easiest and most difficult course.

Growth mindset dominant pattern. I hypothesize that students may be more likely to hold a growth mindset dominant pattern for their most difficult course compared to their easiest course because they may not consider their intelligence in their easiest course as something they need to improve or change. On the other hand, students may have a growth mindset dominant pattern for their easiest course because they believe their efforts are likely to improve their

ability or intelligence in a course they find easy compared to a course they find difficult. Given than there is little research on mindsets for contexts of different difficulties, these are largely exploratory predictions.

Fixed mindset dominant pattern. I hypothesize that students may be likely to hold a fixed mindset dominant pattern for their most difficult course because they may find the class to be so difficult, they do not believe they can improve upon their abilities or intelligence. On the other hand, students may endorse a fixed mindset dominant pattern for their easiest course if their innate intelligence is why they find the course easy in the first place.

Balanced pattern. Some students may endorse both a growth mindset and fixed mindset to the same extent. Because previous literature has seldom looked at the possibility that students may endorse multiple types of mindsets, it is difficult to make context-dependent predictions for these students.

Stability over time. I hypothesize that students' general growth mindsets and general fixed mindsets may be relatively stable over the course of the quarter. Specifically, they may be less likely to change than course-specific mindsets. I expect general mindsets to be more stable over time compared to course-specific mindsets over time because the experiences and feedback the student receives in their courses may influence the beliefs they have regarding the malleability of their intelligence within that course. This may not have as much of an impact on their general beliefs about intelligence. Although this study does not explore whether students who struggle in their courses are more likely to change their mindset, performance feedback may be one factor that may influence students' beliefs. The patterns of growth and fixed mindsets may look relatively the same over time. I hypothesize that course-specific mindsets will be less stable over time and that students may belong to a different pattern at the end of the quarter. I

expect that patterns will be most likely to change for the students' most difficult course compared to their easiest course because students will likely perform closer to their expectations and probably perform better in their easiest course. For this reason, challenging contexts may provide an environment that causes the students to reevaluate beliefs about their intelligence to a greater extent than an easy context. Students who begin by having fixed mindset dominant patterns may the least likely to change their mindset beliefs over time because of their tendency to respond to increasing challenges with helpless strategies or giving up, which may reinforce their fixed mindset beliefs. Students who begin by having a growth mindset dominant pattern may continue having the same pattern in their easiest course but may shift to having a fixed mindset dominant pattern for their most difficult course if their efforts do not increase their performance and they are repeatedly met with challenges they cannot overcome.

Methods

Design & Participants

In the fall of 2017, a total of 177 undergraduate students were recruited to join the nine-month longitudinal study entitled The Early College Motivation Project. Participants were recruited after the lead researcher visited several undergraduate classes during Week 0-2 of fall quarter. Students were recruited from two biology courses and four education courses in order to recruit students with a variety of majors. Surveys were administered online three times during each quarter for one academic year. During the fall quarter, Wave 1 occurred before participants' midterm exam (Week 3-5), Wave 2 occurred after participants' midterm exam (Week 7-9), and Wave 3 occurred after final exams during the holiday break following fall quarter. Participants had two to three weeks to complete each survey. They were compensated for each survey the day

after survey was due. The study continued for six more waves during the winter and spring quarters; however, this study utilizes data only from the first three waves of the study.

The lead researcher recruited 177 undergraduate students (75% female; 35% freshman; 65% sophomore) for the research panel at the University of California, Irvine (UCI). The participants agreed to be a part of the study and opted in to receive emails for surveys. Even if a participant did not complete all waves of the study, they continued to receive surveys for subsequent waves. The average age of participants was18 years and 7 months old. The ethnic breakdown of the sample closely matched the overall sample of UCI students (50% Asian, 27% Hispanic/Latino, 17% White, 2% Black, and 0.5% Native American). There were 12.5% international students and 53% of students are first generation college students. These numbers are comparable to UCI overall, where 46.8 newly enrolled students were first-generation students and16.7% of the student body are international students in 2017. Of the 70% who declared a major, 75% chose a liberal art major, 11% chose a STEM field, 9% chose business, and 5% chose a fine art major. 92% of participants completed Wave 1, 89% completed Wave 2, and 80% completed Wave 3.

Procedure

The lead researcher visited classes to give a brief presentation about the study to recruit interested freshmen and sophomores in two classes in the Biological Sciences department (n=618) and three classes in the Education department (n=355) in order to recruit students with varied majors. The biological sciences classes were non-major courses that are open to anyone at UCI. Two of the education courses were major requirements for education science majors and one was an elective. Students listened to a brief presentation about an overview of the study, eligibility requirements, and compensation. The total number of enrolled students in the five

classes was approximately 973 students. Of the 973 students who were presented with the opportunity to join the study, 336 students expressed interest in the study. Interested students signed up on a sign-up sheet and were contacted within a few days with a recruitment survey that allowed them to read the consent form and consent to joining the study. 177 students of the 183 students who completed the recruitment survey were eligible for the study (e.g., they were freshman or sophomores and above age 18), yielding a total recruitment rate of 18%. In the final sample, 48.6% students were recruited from Bio Sci 35: Brain and Behavior, 29.9% were recruited from Bio Sci 36: Drugs and the Brain, 14.1% students were recruited from Education 50: Issues in K-12 Education, 6.8% were recruited from Education 10: Research Design, and 0.6% were recruited from Education 55: Knowledge and Learning in Math and Science. Students received a personalized link to their first survey during Week 3 of the fall quarter. Students were automatically reminded via email to complete the survey if they had not completed it within seven, ten, and thirteen days of the allotted two-week period. All subsequent surveys were sent via personalized link to students every 3 to 4 weeks.

Sample Characteristics

The present study included 137 participants from the original research panel. 30 participants were dropped because they did not complete both Wave 1 and Wave 3 of data collection. The average age of participants in the subsample is 18 years and 7 months old. The ethnic breakdown of the subsample closely matches the overall sample of UCI students (50% Asian, 25% Hispanic/Latino, 10% White, 2% Black, 6% Multiracial-White and Asian, 4% Multiracial-White and Hispanic/Latino, 2% Multiracial-other, and 1% Middle Eastern). 12% of the sample are international students and 50% of students are first generation college students. These numbers are comparable to UCI overall, where 46.8% of newly enrolled students were

first-generation students and 16.7% of the student body are international students in 2017. 50% of the subsample was designated by university records as low-income. Of the 94% of students who reported their parents' highest level of education, 12% reported one or more parent had less than a high school education, 21% graduated from high school, 9% attended college but did not graduate, 5% attended vocational/technical school, 6% obtained their associate's degree, 26% obtained their bachelor's degree, 16% obtained their master's degree, and 5% obtained an advanced or professional degree. Major selections varied in the subsample with 29% choosing a social sciences/social ecology major, 14% in education, 5% in business, 4% in humanities, 4% in computer science, 4% in public health, 3% in engineering, 4% in biological/physical sciences, and 1% in fine arts. 4% of students had a double major and 28% of students were undeclared/unaffiliated.

Measures

All measures were pilot tested with former undergraduate students for clarity. Students general growth mindset and fixed mindset and course-specific growth mindset and fixed mindset were measured. The course-specific mindsets were measured for two courses specified by the student—their easiest and most difficult course. Students were asked to specify their hardest and easiest courses in the first survey of the quarter. Their responses were automatically filled into subsequent surveys; however, during the mid-quarter survey, students were asked to confirm that they were still enrolled in the courses that they specified. If they had dropped the first course they specified, they were asked to specify their new hardest and/or easiest course. This response was then automatically inserted into the final survey. In the final survey, it was assumed that students could no longer drop any of their courses because all drop periods had ended before the mid-quarter survey. Thus, the survey did not account for students changing their mind about

what course was their hardest/easiest and only took into account that they were still enrolled in the class they had specified at the beginning. Only three students dropped their initially reported hardest course and no students dropped their initially reported easiest course.

General mindset (Implicit Theories of Intelligence) scales. Students' general mindsets were measured using two scales composed of 6 items from the Implicit Theories of Intelligence Scale (Dweck, 2000). Students were told to rate the extent to which they agreed with each statement on a 6-point Likert scale (1 = *Strongly disagree*; 6 = *Strongly agree*). General mindset was assessed at both Wave 1 and Wave 3. In a previous study, the test-retest reliability for this measure over a two-week period was .77 (Hong et al., 1999).

Fixed mindset scale. The fixed mindset scale contains three entity theory items (e.g., "You have a certain amount of intelligence, and you really can't do much to change it"; Dweck, 2000). Strong agreement with this scale would indicate that a student believes in the fixedness of intelligence. (1= *Strongly disagree* to 6 = *Strongly agree*; Wave 1: $\alpha = .91$; Wave 3: $\alpha = .93$).

Growth mindset scale. The growth mindset scale contains three incremental theory items (e.g., "You can always greatly change how intelligent you are"). Strong agreement with this scale would indicate that a student believes in the malleability of intelligence. (1= *Strongly disagree* to 6 = *Strongly agree*; Wave 1: $\alpha = .86$; Wave 3: $\alpha = .92$).

Course-specific mindset scales. The course-specific versions of the mindset scales were based on the original measure by Dweck and colleagues (Dweck, 2000). De Castella and Byrne (2015) revised the original mindset scale to create a self-theory scale in which the original items were re-worded so that each statement reflect a first-person claim about the extent to which intelligence was fixed or malleable. I further revised the self-theory scale to make each statement specific to the most difficult course and the easiest course, as specified by the student. Efforts

were made to ensure that the items aligned closely with the original mindset items. Students were told to rate the extent to which they agreed with each statement on a Likert scale of 1-6 (1 = *Strongly disagree*; 6 = *Strongly agree*). Course-specific personal mindsets were assessed at every wave in the study.

Course-specific fixed mindset in the most difficult course. The fixed mindset scale contains three items that indicate how much a student believes in the fixedness of their own intelligence in their most difficult course (e.g., I can learn new things in this course, but I don't have the ability to change my basic intelligence in this course). Strong agreement with this scale would indicate that a student believes their own intelligence is fixed in a specific course. (1= *Strongly disagree* to 6 = *Strongly agree*; Wave 1: α = .92; Wave 3: α = .94).

Course-specific fixed mindset in the easiest course. The fixed mindset scale contains three items that indicate how much a student believes in the fixedness of their own intelligence in their easiest course. The items were exactly the same as above except specified the students' self-reported easiest course. (1= *Strongly disagree* to 6 = *Strongly agree*; Wave 1: α = .95; Wave 3: α = .96).

Course-specific growth mindset in the most difficult course. The growth mindset scale contains three items that indicate how much a student believes in the malleability of their own intelligence in their most difficult course (e.g., "Regardless of my current intelligence level in this course, I think I have the capacity to change it quite a bit"). Strong agreement with this scale would indicate that a student believes they can change their own intelligence in a specific course. (1= *Strongly disagree* to 6 = *Strongly agree*; Wave 1: α = .94; Wave 3: α = .95).

Course-specific growth mindset in the easiest course. The growth mindset scale contains three items that indicate how much a student believes in the malleability of their own intelligence

in their easiest course. The items were exactly the same as above except specified the students' self-reported easiest course. (1= *Strongly disagree* to 6 = *Strongly agree*; Wave 1: α = .97; Wave 3: α = .93).

Analysis Plan

Confirmatory factor analysis (CFA). I used CFA to verify the factor structure of each general and course-specific mindset scale. Given that the course-specific mindset scale is an adaptation of the well-established mindset scale developed by Dweck and colleagues, it is important to test the hypothesis that the underlying latent constructs of a growth mindset and fixed mindset exist for the adapted scales as well. Structural equation modeling was used, relying on several statistical tests to determine the adequacy of the model fit to the data (e.g., chi-square test, comparative fit index, and RMSEA).

Bivariate correlations. I used bivariate correlations as a preliminary exploration of the individual stability of students' general mindsets and course-specific mindsets. For example, mindset beliefs that are less strongly correlated at Wave 1 and Wave 3 may indicate that that particular belief may be changing in different ways over time. If all beliefs are changing in the same way over time, they will be highly correlated. Bivariate correlations also give an indication of the stability in the pattern of individual differences, show how students' separate growth and fixed mindset beliefs are related to each other, and give an indication of how students' general and course-specific mindsets for their easiest and most difficult class are related to each other.

Variable-centered analyses. Multivariate analysis of covariance (MANCOVA) was used to test for significant within-subject differences in the six mindset constructs at the beginning of the quarter and post-quarter. The independent variable was time. The dependent variables were general growth mindset beliefs, general fixed mindset beliefs, course-specific

growth mindset beliefs, and course-specific fixed mindset beliefs in the students' reported easiest and most difficult courses. I tested for the effect of an interaction between time and each construct in order to understand whether some mindset constructs are likely to change to a greater extent over the course of an academic quarter compared to others. Covariates included class level.

Pattern centered analysis. I used cluster analysis to uncover patterns in general mindsets and course-specific personal mindsets. Cluster analysis is a pattern-centered technique in which individuals are put into homogeneous groups based on the pattern of their responses to clustering variables (see Bergman et al., 2003). Three separate cluster analyses were conducted at Wave 1 and Wave 3, for a total of six cluster analyses:

1. General mindset pattern: Growth mindset and fixed mindset
2. Easiest course-specific-mindset pattern: growth mindset and fixed mindset
3. Most difficult course-specific mindset pattern: growth mindset and fixed mindset

Following suggestions and our theoretical framework, I separately clustered general mindset and course-specific mindsets because I believe these beliefs operate at different levels. The general mindset beliefs may be understood to apply to intelligence in general, either specific to the individual or broadly to everyone in general, while the course-specific mindset points to the individual's particular beliefs about the malleability of their intelligence in a specific domain. Although these beliefs may be related in some individuals, other may hold course-specific mindsets that are very different than their general mindset. I clustered the course-specific mindsets separately for the students' reported most difficult course and easiest course because I believe that the specific context will greatly influence students' mindsets and that these beliefs may not necessarily be related to each other across contexts.

Following the steps of pattern-centered analysis delineated by Bergman et al. (2003) and Vargha, Torma, and Bergman (2015), I used the ROPstat statistical package (www.ropstat.com). The advantage of this procedure is that it makes no assumptions about the distributions of the responses on the measures. I used a set of modules in ROPstat that comprise four steps for uncovering patterns that include analyzing and imputing missing data, identifying and removing residue multivariate outliers, deciding on an optimal number of clusters, and relocating cases to better-fitting clusters (Vargha et al., 2015; Bergman et al., 2003). The optimal number of cluster solutions was determined using a scree-type plot identified the statistically justifiable upper and lower number of cluster groups utilizing the error sum of squares (ESS) of solutions ranging from 2 to 20 clusters. Theoretical considerations were also be used as criteria to decide upon the optimal number of clusters. K-means relocation improved the quality of the optimal cluster solution by moving cases to better-fitting clusters.

Linking mindset clusters over time. In order to understand the stability of general mindsets and course-specific mindsets over one quarter, the patterns at the beginning of the quarter were compared to the patterns at the end of the quarter, using the LICUR (Linking of Clusters after removal of a Residue) method (Bergman et al., 2000). Separate cross-sectional cluster analyses were performed on each set of variables at each time point and then the resulting classifications are linked. The goal of LICUR is to provide a basic analysis of pattern development from an inter-individual perspective using a snap-snot linking approach (Bergman et al., 2003). The clusters were compared across both time points for structural stability (are there similar profiles at the beginning and end of the quarter?) and individual stability (do students tend to stay in the same cluster across the quarter?).

The first step of the LICUR procedure, as outlined by Bergman et al. (2003), is to identify a residue separately at each time point. The second step is to cluster analyze the subjects separately at each time point. The third step is to relate the classification at adjacent ages to one another by cross-tabulation of time-adjoining classifications and test for significant types of cluster membership combinations using exact cellwise tests. Testing for significant cluster combinations—overrepresented or underrepresented cells—can be problematic using ordinary chi-square-based statistics, as the normal approximations are not accurate. Bergman et al. (2003) advise to use exact cellwise tests and an improved Bonferroni correction approach known as Holm's procedure to adjust the nominal significance levels.

Handling Missing Data

No one in the subsample was missing data on any of the key mindset variables. Thirty participants were dropped because they did not complete surveys for both Wave 1 and Wave 3. Independent-samples t-tests and chi-square test for independence determined that those individuals who were dropped from the analysis sample did not significantly differ from those with complete data on demographic or university data. Independent-samples t-tests were conducted to compare the end of quarter GPA and age for those missing data and those with complete data. There was no significant difference in end of quarter GPA (on a scale of 0 to 4.0) for those who were missing data (M = 2.95, SD = .84) and those who had complete data (M = 3.17, SD = .65); t (165) = -1.61, p = .11 (two-tailed). The magnitude of differences in the means (mean difference = -.22, 95% CI: -.49 to 0.05) was small (eta squared = 0.02). There was no significant difference in age for those who were missing data (M = 18.76, SD = .62) and those who had complete data (M = 18.62, SD = .57); t (155) = 1.06, p = .11 (two-tailed). The magnitude of differences in the means (mean difference = .14, 95% CI: -.12 to .41) was very

small (eta squared = 0.007). Chi-square tests for independence (with Yates Continuity Correction) indicated no significant associations between students who are missing and students who have complete data on the following variables: gender, χ^2 (1, n = 167) = 1.64, p = .20, phi = -.12; class level, χ^2 (1, n = 167) = 0, p = 1, phi =.001; low-income status, χ^2 (1, n = 167) = 0, p = 1, phi = -.003; international student status, χ^2 (1, n = 167) = .33, p = .57, phi = -.07; and college generation status, χ^2 (1, n = 163) = 2.42, p = .12, phi = -.14. Chi-square tests for independence also indicated no significant associations between missing status and: race/ethnicity, χ^2 (7, n = 157) = 4.17, p = .76, phi =.16; highest level of parent's education, χ^2 (7, n = 149) = 11.38, p = .12, phi = .28; and college major, χ^2 (15, n = 167) = 15.37, p = .43, phi = .30.

Results

Descriptive Summary

I examined the key mindset variables from each timepoint on a descriptive level. Means for the growth mindset scales are skewed upward, indicating that most students agree with growth mindset indicators. Means for fixed mindset scales are skewed downward, indicating that most students disagree with fixed mindset indicators. This holds consistent across general mindset beliefs and course-specific mindsets in the most difficult course and easiest course. A correlation matrix for the six mindset scales at each time point and covariates (class level, gender, GPA) is provided in Table 1.1. Stronger general fixed mindsets are associated with weaker general growth mindsets; stronger course-specific fixed mindsets are associated with weaker course-specific growth mindsets in both the most difficult and easiest course. At both waves, stronger general fixed mindsets are associated with stronger course-specific fixed mindsets; stronger general growth mindsets are associated with stronger course specific growth mindsets. This indicates that students' general mindset beliefs are closely related to their course-

specific mindsets. General fixed mindsets at Wave 1 and Wave 3 are strongly positively associated. General growth mindsets at Wave 1 and Wave 3 are strongly positively associated. These associations indicate that students' general mindsets beliefs are stable or changing in the same way over time. Course-specific fixed mindsets at Wave 1 and Wave 3 are moderately positively associated in the most difficult course but weakly positively associated in the easiest course, indicating that fixed mindset beliefs for specific courses may change in different ways over time. Course-specific growth mindsets at Wave 1 and Wave 3 are moderately positively associated in the most difficult and easiest course, indicating that growth mindset beliefs may be more stable or changing in the same way. All mindset beliefs had weak associations with GPA, class level, and gender.

Checking for Normality

A visual inspection of histograms, normal Q-Q plots, and box plots (Cramer, 1998; Cramer & Howitt, 2004; Doanne & Seward, 2011) showed that Wave 1 general fixed mindset items were approximately normally distributed and that Wave 1 general growth mindset items were slightly skewed upwards. Wave 1 course-specific mindset items were not normally distributed for either the most difficult course or the easiest course. Course-specific fixed mindset items were all skewed downward for both the most difficult course and easiest course. Course-specific growth mindset items were all skewed upward for both the most difficult course and easiest course. A visual inspection of plots indicated that Wave 3 general fixed mindset items were approximately normally distributed and that Wave 3 general growth mindset items were slightly skewed upwards. For the most difficult course, Wave 3 course-specific fixed mindset items were nearly normally distributed and course-specific growth mindset items were skewed upwards. For the easiest course in Wave 3, course-specific fixed mindset items were

slightly skewed downwards, and course-specific growth mindset items were skewed upwards. Table 1.2 and Table 1.3 present the skewness and kurtosis of each item in Wave 1 and Wave 3, respectively. Mahalanobis distance analysis revealed there were two multivariate outliers. Mahalanobis distance is the distance of a particular case from the centroid of the remaining cases, where the centroid is the point created by the means of all the variables (Tabachnick & Fidell, 2007). This analysis picks up on any cases that have a strange pattern of scores across the 12 mindset constructs.

Confirmatory Factor Analysis (CFA)

I conducted a CFA to verify the factor structure of each general and course-specific mindset scale. Given that the course-specific mindset scale is an adaptation of the well-established mindset scale developed by Dweck and colleagues, it was necessary to test the hypothesis that the underlying latent constructs of a growth mindset and fixed mindset exist for the adapted scales as well, using structural equation modeling software in Stata 22, relying on several statistical tests to determine the adequacy of the model fit to the data (e.g., chi-square test, comparative fit index, and RMSEA). I hypothesized six two-factor models to be confirmed in the measurement portion of the model after evaluating the assumptions of univariate and multivariate normality and linearity through SPSS 13. All 137 participants were included in each of the six models; there were no missing data. The six measurement models included: 1) Wave 1 general mindset beliefs; 2) Wave 1 course-specific mindset beliefs in students' most difficult course; 3) Wave 1 course-specific mindset beliefs in students' easiest course; 4) Wave 3 general mindset beliefs; 5) Wave 3 course-specific mindset beliefs in students' most difficult course; and 6) Wave 3 course-specific mindset beliefs in students' easiest course. The two factors in each model included: 1) Fixed mindset and 2) Growth mindset.

For Model 1 (Wave 1 general mindset beliefs), χ^2 (8, n = 137) = 6.12, p = .63, the comparative fit index (CFI) = 1, the Tucker-Lewis fit index (TLI) = 1, and the RMSEA = 0. Those values indicate a good fit between the model and the observed data. For Model 2 (Wave 1 course-specific mindset beliefs in students' most difficult course), χ^2 (8, n = 137) = 5.98, p = .65, the comparative fit index (CFI) = 1, the Tucker-Lewis fit index (TLI) = 1, and the RMSEA = 0. For Model 3 (Wave 1 course-specific mindset beliefs in students' easiest course), χ^2 (8, n = 137) = 12.47, p = .13, the comparative fit index (CFI) = 1, the Tucker-Lewis fit index (TLI) = .99, and the RMSEA = 0.06. Goodness of fit indicators for models 1-3 indicate a good fit between the model and the observed data. For Model 4 (Wave 3 general mindset beliefs), χ^2 (8, n = 137) = 24.58, p = .002, the comparative fit index (CFI) = .98, the Tucker-Lewis fit index (TLI) = .96, and the RMSEA = 0.12. Those values indicate a moderately good fit between the model and the observed data. For Model 5 (Wave 3 course-specific mindset beliefs in students' most difficult course), χ^2 (8, n = 137) = 21.92, p = .01, the comparative fit index (CFI) = .98, the Tucker-Lewis fit index (TLI) = .97, and the RMSEA = 0.11. For Model 6 (Wave 3 course-specific mindset beliefs in students' easiest course), χ^2 (8, n = 137) = 21.39, p = .001, the comparative fit index (CFI) = .99, the Tucker-Lewis fit index (TLI) = .97, and the RMSEA = 0.11. Goodness of fit indicators for models 4-6 indicate a moderately good fit between the model and the observed data. Standardized and unstandardized parameter estimates for each model are provided in Table 1.4. Overall, the Wave 1 models fit the data better than Wave 3 models but in general, parameter estimates indicated a good fit of each mindset scale.

Variable-Centered Analyses

Repeated measures multivariate analysis of covariance (MANCOVA) was performed to investigate within-subject differences in the six mindset constructs at the beginning of the quarter

and post-quarter between freshman and sophomores (see Table 1.5 for a summary of the analyses and Table 1.6 for a summary of group means). Six dependent variables were used: general growth mindset beliefs, general fixed mindset beliefs, course-specific growth mindset beliefs, and course-specific fixed mindset beliefs in the students' reported easiest and most difficult courses. The independent variable was time. Covariates included class level. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, and multicollinearity, with no serious violations noted. There was a statistically significant difference between the two time points on the combined dependent variables, F (6, 130) = 2.71, p = .02; Wilks' Lambda = .89; partial eta squared = .11. There was no statistically significant difference between freshman and sophomores on the combined dependent variables, F (6, 130) = 1.44, p = .20; Wilks' Lambda = .94; partial eta squared = .06. When the results for the dependent variables were considered separately (see Table 5 for summary), the differences to reach statistical significance were in general fixed mindset beliefs, F (1, 136) = 3.94, p = .049; partial eta squared = .03, course-specific fixed mindset beliefs in the hardest class, F (1, 136) = 4.37, p = .04; partial eta squared = .03, and course-specific fixed mindset beliefs in the easiest class, F (1, 136) = 4.89, p = .03; partial eta squared = .04. An inspection of the mean scores indicated that overall, students had statistically significantly weaker general fixed mindsets (Time 1: M = 3.09, SE = .11; Time 2: M = 2.93, SE = .11), stronger course-specific fixed mindsets for their most difficult course (Time 1: M = 2.71, SE = .11; Time 2: M = 2.92, SE = .11), and stronger course-specific fixed mindsets for their easiest course (Time 1: M = 2.49, SE = .11; Time 2: M = 2.75, SE = .11), at the end of the quarter compared to the beginning of the quarter. The interaction between time and class level was not significant.

Pattern Centered Analysis

Cluster analysis was used to uncover and explore patterns in general mindsets and course-specific personal mindsets. Three separate cluster analyses were conducted for Wave 1 and Wave 3, for a total of six cluster analyses:

1. General mindset pattern: Growth mindset and fixed mindset
2. Easiest course-specific-mindset pattern: growth mindset and fixed mindset
3. Most difficult course-specific mindset pattern: growth mindset and fixed mindset

The initial steps of cluster analysis resulted in scree-type plots (see Appendix 1.1 for all plots) that indicated a statistical justification based on the trend of ESS values for selecting as few as three or as many as six cluster groups for each separate analysis. The homogeneity coefficients (HC) of each cluster indicate how homogenous each cluster is relative to the overall sample (Vargha et al., 2015). Each HC of the clusters in the optimal solutions was below the HC of the overall sample, indicating that the clusters are more homogenous than the overall sample and that we have found relatively homogenous subgroups in the cluster solutions. Multivariate outliers were removed prior to each cluster analysis. Because different beliefs were grouped together for each cluster analysis, a multivariate outlier for one analysis may not be considered an outlier for another (e.g., a multivariate outlier in the Wave 1 Easiest Course cluster analysis was not considered an outlier in the Wave 3 analysis.) I evaluated the cluster solutions of each cluster analysis to explore whether any of the patterns that emerged within each solution matched the theoretical predictions of mindset theory. Generally, the optimal solution retained a sizable percentage of the sample within each cluster. The optimal solution also exemplified theoretically distinct and unique profiles. A brief summary of how the optimal number of cluster solutions was chosen and information on multivariate outliers for each analysis is described.

1. Wave 1 General Mindset Clusters: The ESS plot indicated that there was theoretical justification for the optimal number of clusters to be as few as 3 or as many as 6 clusters. The 4-cluster solution displayed the most theoretically distinct profiles. Specifically, a pattern with a small yet sizable group of students with a fixed mindset dominant pattern emerged. The 5- and 6-cluster solutions added additional patterns that closely resembled other patterns already present in the 4-cluster solution. There were no multivariate outliers.

2. Wave 3 General Mindset Clusters: The ESS plot indicated that the optimal number of clusters was as few as 3 or as many as 6 clusters. The 4-cluster solution displayed the most theoretically distinct profiles, expanding upon the 3-cluster solution with the addition of a pattern that indicated a very strong growth mindset and weak fixed mindset. The 5- and 6-cluster solutions did not add any other additional interesting patterns. There were two multivariate outliers removed from this analysis.

3. Wave 1 Hardest Course Mindset Clusters: The ESS plot indicated that the optimal number of clusters was as few as 4 or as many as 6 clusters. The 4-cluster solution displayed the most theoretically distinct profiles. The 5-cluster and 6-cluster solutions did not add additional unique patterns. There were no multivariate outliers.

4. Wave 3 Hardest Course Mindset Clusters: The ESS plot indicated that the optimal number of clusters was as few as 3 or as many as 5 clusters. The 4-cluster solution displayed the most theoretically distinct profiles, expanding upon the 3-cluster solution with the addition of a pattern that indicated a very strong growth mindset and weak fixed mindset. There were two multivariate outliers removed from this analysis.

5. Wave 1 Easiest Course Mindset Clusters: The ESS plot indicated that the optimal number of clusters was as few as 4 or as many as 6 clusters. The 4-cluster solution displayed the most

theoretically distinct and unique profiles. There were two multivariate outliers removed from this analysis.

6. Wave 3 Easiest Course Mindset Clusters: The ESS plot indicated that the optimal number of clusters was as few as 3 or as many as 5 clusters. The 5-cluster solution displayed the most theoretically distinct and unique profiles, expanding on the 3- and 4-cluster solutions with the addition of a pattern that indicated a much stronger fixed mindset compared to a growth mindset. There were no multivariate outliers.

Fixed and Growth Mindset Patterns

The six cluster analyses indicated that there are several different ways students endorse their fixed and growth mindset beliefs. Similar patterns emerged across general beliefs and course-specific beliefs as well as across the beginning of the quarter and end of quarter. Overall, each cluster analysis revealed a Strong Growth Mindset Dominant pattern, Moderate Growth Mindset Dominant Pattern, either a Strong or Moderate Fixed Mindset Dominant pattern, and at least one Balanced pattern, revealing structural stability across the quarter. See Table 1.7 for cluster means and Figure 1.1 for a graphical depiction of the clusters. Figure 1.2 depicts the number of students in each cluster for each type of mindset over time.

General Mindset Patterns. Similar general mindset patterns emerged at the beginning of the quarter (Wave 1) and end of the quarter (Wave 3); thus, they are presented together. Only the fixed mindset dominant profile within each wave differed and is discussed below. For general mindsets, 50% endorsed the Moderate GM Dominant profile, 21% endorsed the Balanced profile, 19% endorsed the Strong GM Dominant profile, and 10% were in the Strong FM Dominant profile at the beginning of the quarter. By the end of the quarter, membership was more varied with 36% of students endorsing the Balanced profile, 30% endorsing the Moderate

GM Dominant profile, 20% were in the Strong GM Dominant profile, and 14% were in the Moderate FM Dominant profile. This indicates that, at the beginning and end of the quarter, most students were likely to endorse more moderate views for their general mindsets, with more students endorsing growth mindset beliefs.

Strong growth mindset dominant pattern (Strong GM). The strong growth mindset dominant pattern (Wave 1: n = 26; HC: 0.44; Wave 3: n = 27; HC: 0.34) was composed of students who had the strongest agreement with growth mindset beliefs (Wave 1: M = 5.42; Wave 3: M = 5.74) and strongest disagreement with fixed mindset beliefs (Wave 1: M = 1.59; Wave 3: M = 1.35).

Moderate growth mindset dominant pattern (Moderate GM). The moderate growth mindset dominant pattern (Wave 1: n = 69; HC: 0.99; Wave 3: n = 40; HC: 0.30) was composed of students who had moderately strong agreement with growth mindset beliefs and moderate disagreement with fixed mindset beliefs. Compared to students in the Strong GM Pattern, students in the Moderate GM pattern endorsed growth mindset beliefs to a lesser extent (Wave 1: M = 4.60; Wave 3: M = 4.90) and fixed mindset beliefs to a greater extent (Wave 1: M = 2.75; Wave 3: M = 2.28). Students in this profile expressed stronger agreement with growth mindset beliefs relative to their fixed mindset beliefs, but to a lesser extent than Strong GM members. This pattern had the largest number of students in Wave 1.

Strong Fixed Mindset Dominant (Strong FM). The strong fixed mindset dominant pattern (Wave 1: n = 13; HC: 0.65) was composed of students who had the strongest fixed mindset beliefs (M = 5.08) and the weakest growth mindset beliefs (M = 2.26). This profile only emerged in Wave 1 and had the fewest students.

Moderate Fixed Mindset Dominant Pattern (Moderate FM). The moderate fixed mindset dominant pattern (Wave 3: n = 19; HC: 0.51) was composed of students who had moderate agreement with fixed mindset beliefs and moderate disagreement with growth mindset beliefs. This profile only emerged in Wave 3. Students in this profile expressed the strongest fixed mindset beliefs (M = 4.77) and weakest growth mindset beliefs (M = 2.84). This pattern had the fewest students in Wave 3.

Balanced pattern. The Balanced pattern (Wave 1: n = 29; HC: 0.60; Wave 3: n = 49; HC: 0.56) was composed of students who have relatively similar growth mindset and fixed mindset beliefs. Students in this pattern expressed similar levels of moderate agreement with growth mindset beliefs (Wave 1: M = 3.92; Wave 3: M = 4.14) and fixed mindset beliefs (Wave 1: M = 4.26; Wave 3: M = 3.67). This pattern had the most students in Wave 3.

Hardest Course Mindset Patterns. Four profiles of hardest course mindset are described for Wave 1 and Wave 3, with the majority of patterns being replicated across both time points. As with general mindsets, only the fixed mindset dominant pattern differed across the two time points in the quarter. For hardest course mindsets, 35% endorsed the Moderate GM Dominant profile, 33% endorsed the Balanced profile, 25% were in the Strong GM Dominant profile, and 7% were in the Strong FM Dominant profile at the beginning of the quarter. By the end of the quarter, 33% of students endorsed the Balanced profile, 32% were in the Moderate GM Dominant profile, 22% endorsed the Moderate FM Dominant profile, and 13% endorsed the Strong GM Dominant profile. Most notably, there is a large decrease in the number of students who endorsed the Strong GM Dominant profile from the beginning to the end of the quarter—a shift that is unique to the hardest course.

Strong growth mindset dominant pattern (Strong GM). The strong growth mindset dominant pattern (Wave 1: *n* = 34; HC: 0.27; Wave 3: *n* = 18; HC: 0.14) was composed of students who had the strongest agreement with growth mindset beliefs (Wave 1: *M* = 5.87; Wave 3: *M* = 5.83) and the weakest agreement with fixed mindset beliefs (Wave 1: *M* = 1.42; Wave 3: *M* = 1.07)for their hardest course. This cluster had the fewest students in Wave 3.

Moderate growth mindset dominant pattern (Moderate GM). The moderate growth mindset dominant pattern (Wave 1: *n* = 48; HC: 0.24; Wave 3: *n* = 43; HC: 0.37) was composed of students who had moderately strong agreement with growth mindset beliefs (Wave 1: *M* = 4.96; Wave 3: *M* = 5.26) and moderate disagreement with fixed mindset beliefs (Wave 1: *M* = 2.26; Wave 3: *M* = 2.19)for their hardest course. This pattern had the largest number of students in Wave 1.

Strong Fixed Mindset Dominant (Strong FM)- The strong fixed mindset dominant pattern (Wave 1: *n* = 10; HC: 1.49) was composed of students who had the strongest agreement with fixed mindset beliefs (*M* = 5.50) and lowest agreement with growth mindset beliefs (*M* = 2.67) for their hardest course. As with the general mindset patterns, this profile only emerged in Wave 1 and had the fewest students.

Moderate Fixed Mindset Dominant Pattern (Moderate FM). The moderate fixed mindset dominant pattern (Wave 3: *n* = 30; HC: 1.32) was composed of students who had moderate agreement with fixed mindset beliefs (*M* = 4.66) and low agreement with growth mindset beliefs (*M* = 3.41) for their hardest course. As with the general mindset patterns, this profile only emerged in Wave 3. Students in this profile expressed the strongest fixed mindset beliefs and weakest growth mindset beliefs in Wave 3.

Balanced pattern. The Balanced pattern (Wave 1: n = 45; HC: 0.58; Wave 3: n = 45; HC: 0.54) was composed of students who have relatively similar growth mindset and fixed mindset beliefs for their hardest course, with slightly stronger growth mindset beliefs. Students in this pattern expressed similar levels of moderate agreement with growth mindset beliefs (Wave 1: *M* = 4.07; Wave 3: *M* = 4.44) and fixed mindset beliefs (Wave 1: *M* = 3.47; Wave 3: *M* = 3.16). This pattern had the most students in Wave 3.

Easiest Course Mindset Patterns. Four profiles of easiest course mindset beliefs are described for Wave 1 and five profiles are described for Wave 3. The fixed mindset dominant presented differently in the two waves. There was also the addition of a second type of Balanced profile in Wave 3. For easiest course mindsets, 50% of students were in the Moderate GM Dominant profile, 23% of students were in the Strong GM Dominant profile, 22% endorsed the Balanced profile, and 5% of students endorsed the Strong FM Dominant profile. By the end of the quarter, 36% of students endorsed the Moderate GM Dominant profile, 21% of students were in the Balanced 2 profile, 18% of students were in the Balanced 1 profile, 18% of students endorsed the Strong GM Dominant profile, and 7% of students were in the Moderate FM Dominant profile.

Strong growth mindset dominant pattern (Strong GM). The strong growth mindset dominant pattern (Wave 1: *n* = 31; HC: 0.19; Wave 3: *n* = 24; HC: 0.10) was composed of students who had the strongest agreement with growth mindset beliefs (Wave 1: *M* = 5.87; Wave 3: *M* = 5.89) and the lowest agreement with fixed mindset beliefs (Wave 1: *M* = 1.15; Wave 3: *M* = 1.03) for their easiest course.

Moderate growth mindset dominant pattern (Moderate GM). The moderate growth mindset dominant pattern (Wave 1: *n* = 67; HC: 0.31; Wave 3: *n* = 49; HC: 0.29) was composed

of students who had moderately strong agreement with growth mindset beliefs (Wave 1: *M* = 5.01; Wave 3: *M* = 5.12) and moderately low agreement with fixed mindset beliefs (Wave 1: *M* = 2.20; Wave 3: *M* = 2.22)for their easiest course. This pattern had the largest number of students in Wave 1 and Wave 3.

Strong Fixed Mindset Dominant (Strong FM)- The strong fixed mindset dominant pattern (Wave 1: *n* = 7; HC: 0.57) was composed of students who had the strongest agreement with fixed mindset beliefs (*M* = 5.62) and lowest agreement with growth mindset beliefs (*M* = 2.00) for their easiest course. As with the general mindset patterns and hardest course mindset patterns, this profile only emerged in Wave 1. This pattern had the fewest students in Wave 1.

Moderate Fixed Mindset Dominant Pattern (Moderate FM). The moderate fixed mindset dominant pattern (Wave 3: *n* = 10; HC: 0.45) was composed of students who had moderate agreement with fixed mindset beliefs (*M* = 4.90) and low agreement with growth mindset beliefs (*M* = 2.67) for their easiest course. As with the general mindset patterns and hardest course mindset patterns, this profile only emerged in Wave 3. Students in this profile expressed the strongest fixed mindset beliefs and weakest growth mindset beliefs in Wave 3. This pattern had the fewest students in Wave 3.

Balanced 1 pattern. The Balanced 1 pattern (Wave 1: n = 30; HC: 0.72; Wave 3: n = 25; HC: 1.05) was composed of students who have relatively similar growth mindset and fixed mindset beliefs for their easiest course. Students in this pattern expressed similar levels of moderate agreement with growth mindset beliefs (Wave 1: *M* = 4.18; Wave 3: *M* = 4.44) and fixed mindset beliefs (Wave 1: *M* = 3.56; Wave 3: *M* = 4.35).

Balanced 2 pattern. The Balanced 2 pattern (Wave 3: n = 29; HC: 0.38) was composed of students who have relatively similar growth mindset (Wave 3: *M* = 3.93) and fixed mindset

beliefs for their easiest course (Wave 3: $M = 2.83$), with slightly stronger growth mindset beliefs. Their growth mindset and fixed mindset were not as strong as those in the Balanced 1 pattern. This pattern only emerged in Wave 3.

Summary. The separate cluster analyses across the beginning of the quarter to the end of the quarter revealed that over one academic quarter, mindset beliefs are relatively structurally stable. In other words, similarly shaped profiles appeared at the beginning and the end of the quarter. One notable exception is that although a strong fixed mindset dominant pattern appeared at the beginning of the quarter, only a moderate fixed mindset dominant pattern appeared at the end of the quarter for general mindset, hardest course mindset, and easiest course mindset. The following section addresses whether students tend to stay in the same cluster across an academic quarter (individual stability).

Linking Mindset Clusters Over Time

The patterns at the beginning of the quarter were compared to the patterns at the end of the quarter using the LICUR (Linking of Clusters after removal of a Residue) method (Bergman et al., 2000). LICUR takes an inter-individual perspective using a snapshot linking approach. The cluster analyses classifications were linked to each other through cross-tabulation and cellwise tests. Chi-square tests of significance and *post hoc* residual cell-wise analysis (as recommended by Bergman et al., 2003; see Beasley & Schumacker, 1995) were used to explore significant overrepresented and underrepresented cluster combinations.

Changes in General Mindset Over Time. Forty-six percent of students remained in the same profile; however, it is important to note although the relative shape of the profile was similar enough between the two points to justify the same cluster name, they may differ at the mean level. For example, 17 out of the 25 students in the Strong Growth Mindset Dominant

profile at the start of the quarter stayed in the same profile at the end of the quarter, but their growth mindset beliefs were slightly stronger and their fixed mindset beliefs were slightly weaker on average. No students with strong growth mindset or strong fixed mindset shifted toward the opposite extreme, indicating that when general mindsets do change, they only change slightly. Pearson's Chi-square test revealed statistically significant cluster linkages that were both overrepresented and underrepresented, $\chi^2(9) = 93.46$, $p < .001$. *Post hoc* residual cell-wise analysis revealed that there was considerable individual stability in general mindsets from the beginning of the quarter to the end of the quarter.

Cluster linkages that were significantly overrepresented included remaining in the Strong GM Dominant profile and Moderate GM Dominant profile, indicating that there were significantly more students who maintained their general mindset beliefs over time when they had strong growth mindset beliefs. 8 out of 13 of the students who began the quarter in the Strong FM Dominant profile transitioned to the Moderate FM Dominant profile, illustrating another significant cluster linkage that indicates students may downwardly adjust their agreement with strong fixed mindset beliefs. Although these students had less extreme fixed mindset beliefs at the end of the quarter, they still had the strongest fixed mindset beliefs compared to any other group of students. Students who began in the Balanced profile were also statistically significantly more likely to remain in the Balanced profile at the end of the quarter.

Cluster linkages that were significantly underrepresented included the transition from the Strong GM Dominant profile to the Balanced profile, the Moderate GM Dominant profile to the Moderate FM Dominant, and the Balanced profile to the Strong GM dominant. The underrepresentation of these cells indicates that when students have strong or moderate growth mindset beliefs, they are significantly less likely to transition to stronger fixed mindset beliefs.

Overall, as hypothesized, students' general mindset beliefs were relatively stable from the beginning to the end of the academic quarter.

Changes in Hardest Course Mindset Over Time. Forty percent of students remained in the same profile over time, indicating that slightly more students may change their hardest course mindset beliefs compared to their general mindset beliefs. Similar to general mindset beliefs, those with more extreme growth and fixed mindset beliefs were less likely to transition to other types of mindset profiles at the end of the quarter. Contrary to my hypothesis, growth mindset beliefs did not weaken, and fixed mindset beliefs did not become stronger in students' most challenging course. Pearson's Chi-square test revealed statistically significant cluster linkages, $\chi^2(9) = 77.19$, $p < .001$. *Post hoc* residual cell-wise analysis revealed that there were statistically significant overrepresented and underrepresented cells.

Cluster linkages that were significantly overrepresented included remaining in the Strong GM Dominant profile and the Balanced profile. This indicates that students were statistically more likely to maintain their strong growth mindset beliefs about their hardest course. The majority (82%) of students who began with in the Strong GM Dominant profile ended up in either the Strong GM Dominant profile or the Moderate GM Dominant profile at the end of the quarter. Forty-nine percent of students started in and remained in the Balanced profile. Thirty-six percent of students who began in the Balanced profile transitioned to the Moderate FM Dominant. Although this cell only almost reached significance, it is important to note that a large portion of students made this transition, indicating that students with less extreme growth and fixed mindsets are either more likely to maintain their initial beliefs or begin agreeing more with fixed mindset beliefs. Another statistically significant cluster transition indicated that 90% percent of students who began in the Strong FM Dominant profile transitioned to the Moderate

FM Dominant profile, indicating just as with general mindsets, students downwardly adjust their fixed mindset beliefs for their hardest course.

Cluster linkages that were significantly underrepresented included the transition from the Strong GM Dominant profile to the Balanced profile, Moderate GM Dominant to the Moderate FM dominant, Balanced profile to the Strong GM Dominant, and Balanced profile to the Moderate GM Dominant profile. These transitions indicate that students with moderate to strong agreement with growth mindset beliefs are less likely to transition to other types of mindset profiles. Students who began with Balanced beliefs were less likely to transition to stronger growth mindset beliefs and more likely to transition to stronger fixed mindset beliefs. Overall, hardest course mindset beliefs were relatively stable for some individuals over time, especially those with more extreme beliefs, which was contrary to my hypothesis.

Changes in Easiest Course Mindset Over Time. Forty-one percent of students remained in the same easiest course mindset profile across the academic quarter. Students with stronger growth mindset or stronger fixed mindset beliefs were less likely to transition to other types of mindset profiles, indicating relatively high individual stability for those with more extreme beliefs. Pearson's Chi-square test revealed statistically significant cluster linkages, $\chi^2(12) = 61.52$, $p < .001$. *Post hoc* residual cell-wise analysis revealed that there were statistically significant overrepresented and underrepresented cells.

Cluster linkages that were significantly overrepresented included remaining in the Strong GM Dominant profile and the Moderate GM Dominant profile. Eighty-one percent of students who began in the Strong GM Dominant profile either remained in the Strong GM Dominant profile or transitioned to the Moderate GM Dominant profile. As found with general mindsets and hardest course mindsets, students with moderate to strong agreement with growth mindsets

were less likely to transition to other types of mindset profiles. Other significantly overrepresented cluster linkages included the transition from the Strong FM Dominant profile to the Moderate FM Dominant and the Balanced profile to the Moderate FM Dominant. Three out of seven of the students who started off in the Strong FM Dominant Profile transitioned to the Moderate FM Dominant profile, mirroring previous findings with general mindsets and hardest course mindsets. Although only 20% of students who started off in the Balanced profile transitioned to the Moderate FM Dominant profile, this was a notable transition given that at the end of the quarter, 60% of students in the Moderate FM Dominant profile used to have Balanced profiles at the start of the quarter. Cluster linkages that were significantly underrepresented solely included the transition from the Balanced profile to the Moderate GM Dominant. This indicates that even for students' easiest classes, less extreme mindset beliefs are more likely to shift toward stronger fixed mindset beliefs and weaker growth mindset beliefs instead of stronger growth mindset beliefs over the course of a quarter—a finding that was trending toward significance for students' hardest course mindsets.

Summary. Overall, findings from LICUR analyses indicated that there is considerable individual stability in general, hardest course, and easiest course mindsets. Given that statistically significant cluster transitions were quite similar across the three types of mindsets, students may not differentiate in the way they change these mindset beliefs over the course of a quarter. Notable findings include that, as expected, students who had moderate to strong growth mindset beliefs tended to maintain their beliefs over time; however, contrary to expectations, students who started off with strong fixed mindset beliefs tended to slightly lessen the strength of their agreement with fixed mindset beliefs over time. This was true across general mindsets and course-specific mindsets. For course-specific mindsets in particular, students with less extreme

mindset beliefs in the Balanced profiles tended to either remain in the same profile or shifted to stronger fixed mindset views.

Discussion

The three-fold analyses (variable approach, pattern-centered approach, and cluster linking) allowed me to take the first steps into exploring how mindsets function as a pattern of beliefs, how they might change over the course of a quarter, and how these beliefs may differ depending on the context in which students think about them. In general, the pattern-centered results complemented and expanded upon the variable-centered findings by offering a more nuanced depiction of the individual differences in mindsets.

The present study aimed to explore the stability of two different types of mindset beliefs, general beliefs and course-specific beliefs about the malleability of intelligence, in two different academic contexts, students' self-reported easiest and most challenging courses, over the course of an academic quarter. Our first research aim, utilizing a variable-centered approach, was to explore the stability of four types of mindsets—general growth mindsets, general fixed mindsets, course specific growth mindset, and course-specific fixed mindsets over the course of a quarter. Findings indicated that the three growth mindset beliefs did not change over time; however, the three types of fixed mindset beliefs differed from the beginning of the quarter compared to the end of the quarter, with general mindsets weakening while both the hardest course and easiest course fixed mindsets strengthening over time. The second and third aim of the study, utilizing a pattern-centered approach, was to explore the individual and structural stability of the aforementioned three types of mindsets in students' easiest and most difficult courses. Pattern analyses revealed several different types of ways student endorse fixed and growth mindset beliefs together and these patterns were relatively consistent across general and course-specific

mindsets, reflecting relative structural stability of mindset beliefs across an academic quarter. Indicative of individual stability, the way students endorse these beliefs may not be likely to change much over the course of a quarter.

Different Levels of Tandem Growth and Fixed Mindset Beliefs

Dweck (2015) suggested in a commentary that it was possible for individuals to hold multiple types of mindsets, but research has seldom explored this idea. Indeed, students appear to have different ways of endorsing growth mindset beliefs relative to their fixed mindset beliefs, in general and for their specific courses; however, the way these beliefs are endorsed do not seem to differ across the three types of mindset beliefs explored in this study. As suggested by Dweck and colleagues (cite), some students strongly endorsed a growth mindset while strongly rejecting fixed mindset beliefs (Strong Growth Mindset Dominant), and other students did the same but to a lesser extent (Moderate Growth Mindset Dominant). Given that Dweck and colleagues extensively discuss the harmful ramifications of having a fixed mindset, it was notable that only between five and ten percent of the sample endorsed very strong fixed mindsets and moderately disagreed with growth mindset beliefs at the beginning of the quarter (Strong FM Dominant), indicating that perhaps this was not a very common belief system. Indeed, by the end of the quarter, the Strong FM Dominant was replaced by the Moderate FM Dominant profile in which students continued to strongly agree with fixed mindset beliefs but also had low to moderate growth mindset beliefs. In each of the mindset types, a relatively undiscussed profile emerged—the Balanced profile. Students in the Balanced profile on average moderately agreed with both growth mindset and fixed mindset beliefs, indicating that perhaps they may not feel incredibly strongly about the malleability of their intelligence or they may be more unsure compared to students in other profiles. Although the same types of profiles emerged across the three types of

mindset beliefs, membership within each profile over time differed. At the beginning and end of the quarter, most students were likely to endorse more moderate views for their general mindsets, with more students endorsing growth mindset beliefs. For their hardest courses, we see more students depart from the profiles that endorse very strong to moderate growth mindset beliefs and a greater number of students endorsing more moderate beliefs. For their easiest courses, the lack of change in group membership percentages indicates that at the beginning and the end of the quarter, most students were likely to endorse more moderate growth mindset beliefs or balanced mindsets.

Weakening Fixed Mindset Beliefs Over Time

Students in the most extreme directions of fixed mindset beliefs, either in complete strong agreement or strong disagreement, tended to modify their views slightly by the end of the quarter. The variable-centered analyses indicated that over the course of the quarter, general fixed mindset beliefs weakened as a whole, and the pattern-centered analyses revealed this was notably true for those who started off with very strong general fixed mindset beliefs. One result of this shift in beliefs was that the Strong Fixed Mindset Dominant pattern was entirely replaced by the Moderate Fixed Mindset Dominant profile in all three types of mindsets. Even those students who began with very low agreement with fixed mindset beliefs (e.g., students in the Strong GM Dominant profile and Moderate GM Dominant profile) had further weakened beliefs. One optimistic explanation for why students fixed mindset beliefs may undergo a shift over an academic quarter is that at the cusp of starting a new course, they may be more apprehensive about the malleability of their intelligence and tend to agree that the causes for their academic failures are rooted in something unchangeable, causing them to think there is nothing they can do to increase their intelligence (Dweck & Leggett, 1988; Weiner, 1972). Students may be less

optimistic without knowing what is in store for them throughout the course of the quarter and may believe that their intelligence may not grow or develop.

Interestingly, this trend was just as likely to occur for students' most difficult courses, easiest courses, and even general beliefs about their intelligence, which differed from my predictions based on previous findings that course-specific mindsets (in this case, math mindsets) were significantly more fixed than students' general mindsets (Shively & Ryan, 2013). The findings in the present study may differ because students were asked to report their most difficult course, such that we might expect more variability than if we looked at the mindsets in only one subject or one specific course. Math intelligence may be thought of in qualitatively different ways than other types of intelligence in the social sciences or physical sciences.

On the other hand, McCutchen et al. (2016) did not find that mindsets differed across subject domain, but that the same mindsets differentially predicted performance across different subjects. In other words, even though students held the same mindset for both their courses, having a stronger fixed mindset for their math course was more harmful to their performance than the same level of fixed mindset beliefs for their reading courses. Although the present study did not measure the outcomes of students with particular mindsets, future studies should explore if having a fixed mindset for a course that one finds very difficult is more harmful for performance compared to having a fixed mindset for a class that students find easier, given that the impact of a mindset seems to differ based on subject domain. This may explain why all three fixed mindsets measured in this study seemed to change in the same way. By the end of the quarter, after experiencing the course and other elements of their academic year, and perhaps after experiencing a growth in their intelligence, students may have adjusted all of their fixed mindset beliefs accordingly and perhaps may be more convinced that their intelligence is

mutable. To what degree this slight shift impacts their subsequence performance is yet to be determined. It is also important to note that although students downwardly adjusted their agreement with fixed mindset beliefs, they only did so to a small degree. In fact, those students who shifted to the Moderate FM Dominant profile, still had the strongest fixed mindset beliefs compared to any other group of students.

Growth Mindsets are Reinforced Over Time

Findings indicated that very strong growth mindset beliefs and very weak fixed mindset beliefs may be reinforced and maintained over time. This was true for both general mindsets and course-specific mindsets. Complementing this finding, the variable-centered approach also revealed that over time, growth mindset beliefs overall were not likely to change much over the quarter. Students who strongly believe in a growth mindset are less likely to doubt their ability to succeed, from the start and especially in the face of challenges and even failure (Henderson & Dweck, 1990). Thus, even if they do face failures, they respond with increased effort, illustrating one reason why students who already have well-formed growth mindsets are less likely to falter in their initial beliefs. Students who were in the Strong GM Dominant profile and the Moderate GM Dominant profile were most likely to maintain their beliefs, especially for general mindsets and easiest course mindsets. This finding complements the relatively stable mindsets over time observed by Robins and Pals (2002) who suggested that individuals react differently to the same college achievement environment depending on their traits, beliefs, and goals, such that the academic context reinforces individuals' pre-existing beliefs about their intelligence and abilities.

In the hardest courses, students who began with strong growth mindsets were more likely to stay in the same profile, but this was not necessarily true if they were in the Moderate GM

Dominant profile, indicating that perhaps some contextual factor in their hardest course causes those with less extreme agreement to shift to even lesser agreement with growth mindset beliefs and stronger agreement with fixed mindset beliefs by the end of the quarter. This finding exemplifies how a pattern-centered approach illuminates systematic change at the individual level, even though growth mindsets as a whole appear to be relatively stable. Furthermore, this expands upon findings by Shively and Ryan (2013) that indicated that college students' growth mindsets about their math intelligence became weaker over the course of a semester. They also argued that math intelligence would be more likely to change over a semester because students' experiences in their courses would be more likely to influence course-specific intelligence rather than their general intelligence. Only in the mindset profiles for the hardest course do we see a sizable decrease in the number of students who endorse a Strong GM Dominant profile, indicating that there is a shift in students with more extreme views by the end of the quarter only for the hardest course. However, in the present study, we do not distinguish between the types of courses that students reported as their most difficult. It is possible that intelligence beliefs in math courses change in different ways than intelligence in liberal arts courses, for example. This may be because of the way academic performance is measured differently across subject domain. While students' grades are determined by their performance on objective tests with absolute incorrect and correct answers in their math and science courses, their success in writing courses are measured through more subjective criteria, which may heavily influence how students perceive their academic success and intelligence in these courses. Future studies should explore how the different ways academic performance is measured impacts students' beliefs about their intelligence.

Another explanation for why students with the strongest growth mindset belief were most likely to continue to maintain their beliefs may be that they were quite confident from the beginning in their ability to change and develop their level of intelligence in general or for their specific courses. Henderson and Dweck (1990) refer to this as the protective quality of a growth mindset. Their experiences throughout the quarter may have had little impact on their general intelligence beliefs or their beliefs for their easiest course. On the other hand, we may see more nuanced shifts in beliefs for students' hardest courses. As I predicted, given the challenging experiences and the outcomes they faced throughout their quarter in their most challenging course, students may be less convinced that their intelligence about a specific subject is malleable with the potential to grow or change. When students are faced with challenges, they are still more likely to believe they have the power to improve their abilities through effort, but maybe not to the same extent as before they experienced these challenges.

Balanced Beliefs are Most Likely to Change

For their hardest and easiest course mindsets, students who had less extreme mindset beliefs (e.g., those in the Balanced profile), who tended to not agree with one mindset more than the other, were more likely to maintain their mindset or shift to stronger fixed mindset beliefs by the end of the quarter. This indicates that when students' mindset beliefs are less extreme, the context and experiences in the course may serve to shape their beliefs over time. Given that there were greater shifts in students' Balanced mindsets for their course-specific mindsets compared to their general mindsets, there is evidence that suggests less extreme mindsets may be more malleable to change. Furthermore, although most students were more likely to remain in their Balanced mindsets for their hardest course, those who transitioned to a different mindset tended to shift toward the Moderate Fixed Mindset Dominant profile. Even for their easiest courses,

students were less likely to ever transition to either of the profiles that endorsed growth mindset beliefs much more than fixed mindset beliefs.

It is worth mentioning that the Balanced profiles at the end of the quarter for both the hardest courses and easiest courses changed from their initial shape. By the end of the quarter, the Balanced profile in the hardest course is illustrated by moderate agreement with growth mindset beliefs and slightly weaker fixed mindset beliefs in comparison. In the easiest course, there are two Balanced profiles—one in which both the fixed mindset and growth mindsets are both endorsed at the same level of strong agreement and a second one in which the growth mindset is endorsed slightly more than the fixed mindset. Thus, the students who remain in these profiles may endorse growth mindset beliefs to a greater extent. Students who begin in the Balanced profile may be less sure about their beliefs at the beginning of the quarter about the malleability of their intelligence because their response patterns seem contradictory. For example, they might agree with the statement "I have a certain amount of intelligence, and I really can't do much to change it," and "I can always greatly change how intelligent I am," to the same extent about the same course, indicating that they might not have very strong feelings either way. The responses of students in the Balanced profile shed light on how students may think about mindset constructs. In past studies, mindsets have been measured on a scale that treats a fixed mindset and growth mindset as a dichotomous variable that assumes disagreement with the fixed mindset scale means agreement with growth mindset ideas. Other studies have utilized a summative score that reverses growth mindset items and combines all items on the same scale, assuming that a growth mindset is the opposite of a fixed mindset. In this case, this was not true for individuals in the Balanced profile who seemed to agree with both constructs to the same extent. As they experience the course and learn more about their intelligence through

their performance, their mindsets may become more structured and defined, resulting in some students endorsing stronger growth mindset beliefs relative to their fixed mindset beliefs or vice versa. The primary driver of this shift in students' mindset, and the reason behind why a student may become more growth oriented or more fixed in their beliefs, is yet to be determined.

Are Mindsets State-like or Trait-like?

Findings revealed that students indeed have different ways of endorsing their growth mindset beliefs relative to their fixed mindset beliefs and that this often presents in varying degrees and levels, about their general beliefs about their intelligence and their course-specific intelligence. It has typically been suggested that mindsets are stable, trait-like characteristics, and yet many interventions and trainings are designed to and, in fact, do change mindset beliefs through short and relatively simple interventions. My findings indicate that mindsets do have the ability to change, even over a relatively short amount of time of ten weeks. Even though these changes are more or less subtle, what is remarkable is that mindsets appear to change in different ways depending on what belief system a student endorsed in the beginning. This is further dependent on the extent to which they endorse particular beliefs. Moreover, when students' beliefs shifted, it was without any type of intervention or training. These findings lend empirical evidence to Dweck's (2007, 2010) statements that it is possible for individuals to change their beliefs about their intelligence. Given that 40-46% of students' mindsets did not change over the course of the quarter, we might say that mindsets may be more trait-like and that the beliefs that we start off with are not likely to be altered, especially when they are very strong. On the other hand, an academic quarter is too short of a time to see changes in mindset that may occur at a more macrolevel. For other students who are less sure about the malleability of their intelligence, mindsets may be a state of mind and shift as their perceptions of their performance take form and

develop. For the students who did transition to a different mindset by the end of the quarter, it is yet to be seen if their mindsets continue to change with each academic experience or if it eventually shifts to a more trait-like mindset.

Limitations and Future Directions

The results of the present study illuminated several features of how mindsets may develop over the course of an academic quarter; however, many questions are left unanswered. A ten-week academic quarter may not be enough time to see marked changes in students' mindsets. Future studies should explore whether general mindsets change over longer periods of time, such as from the beginning of freshman year to the end, or during each year until graduation. However, given that students change their courses each quarter and are unlikely to retake the same classes year to year, it may be more useful to see how students' mindsets regarding a particularly challenging subject domain develop over the course of their time in college. Future studies should continue to measure mindsets at small intervals of time to assess change over longer stretches of time, especially for those students who transitioned to stronger beliefs just over an academic quarter. It is yet to be seen if these students' mindsets would be likely to shift again and again or remain stable.

Given the limited sample size of the study and the lack of variability in student majors, we may see different results in students who have other types of majors outside of the social sciences and liberal arts. In the early years of college, most students are taking pre-requisites and general education courses that may have little to do with the subject matter in their chosen major. Notably, the majority of students in this study were recruited from two non-major biology courses, and many students selected that course as their most difficult course of the quarter. Students mindsets may function differently for course material they are less invested or less

familiar with as compared to the courses regarding more major-specific material. Furthermore, foundational courses may have less impact on altering students' mindsets. Whether or not classes that students chose to take out of interest or passion have a greater impact on their mindsets is yet to be researched.

The sample was predominantly composed of women and we already know from past research that girls and women are more likely to have growth mindsets compared to their male counterparts (Ablard, 2002; Dweck & Bush, 1976; Leondari & Gialamas, 2002), which may explain the high proportion of students who maintained their moderate to strong growth mindset beliefs through the entire quarter. Future studies should attempt to replicate findings with a more gender-balanced sample to understand if males are likely to endorse mindsets in a similar way.

This study primarily explored how three different types of mindsets develop over time, without looking at how these three types of mindsets interact with each other. We still do not know whether students who endorse general growth mindset dominant patterns are more likely to endorse growth mindset patterns for their courses or if the same is true for students who endorse general fixed mindset dominant patterns. We also do not know if there are students who are more likely to change their course-specific mindsets while maintaining their general mindsets or if there are other variations in how these three mindsets are related. Future studies should link all three mindsets together to understand how they develop together.

Now that we know that students do indeed have different ways of endorsing their fixed mindset beliefs relative to their growth mindset beliefs, we must try to understand how these particular beliefs impact other beliefs about themselves and their courses (e.g., their values for their courses, expectancies for success, persistence and engagement in their courses) and their academic performance. Although they seldom discuss mindsets changing, Dweck and colleagues

would suggest that the students who start off with a strong growth mindset dominant pattern and maintain these beliefs would be among the best and hardest working students (Dweck, 2000; Yeager & Dweck, 2012). Students in the moderate to strong fixed mindset dominant patterns would have the greatest declines in performance and struggle the most when material became increasingly challenging (Dweck, 2000; Hong et al, 1999). What about the students who endorse both growth and fixed mindset beliefs to the same extent? Or the students who endorse growth mindset beliefs slightly more than they do fixed mindset beliefs? In the classic Dweck studies, these types of students would have been removed from analysis or lumped in with students who endorsed their more dominant mindset to a greater extent. This study reveals there is a sizable portion of students who fall into this group and that they are most likely to shift in their mindset, even over a short period of time. Future studies might explore the academic outcomes of these students and further delve into the possible reasons why their mindsets change compared to other students.

References

Ablard, K. E. (2002). Achievement goals and implicit theories of intelligence among academically talented students. *Journal for the Education of the Gifted*, *25*(3), 215–232. doi:10.1177/016235320202500302

Bergman, L. R., Magnusson, D., & El-Khouri, B. M. (2003). *Studying individual development in an interindividual context: A person-oriented approach*. Mahwah, NJ: Lawrence Erlbaum Associates.

Blackwell, K. L., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development*, *78*(1), 246–263. doi:10.1111/j.1467-8624.2007.00995.x

Burnette, J. L., O'Boyle, E. H., VanEpps, E. M., Pollack, J. M.,&Finkel, E. J. (2013). Mindsets matter: A meta-analytic review of implicit theories and self-regulation. *Psychological Bulletin, 139*, 655–701. doi:10.1037/a0029531

Cantor, N., Norem, J. K., Niedenthal, P. M., Langston, C. A., & Brower, A. M. (1987). Life tasks and cognitive strategies in a life transition. *Journal of Personality and Social Psychology, 53*, 1178–1191.

Cole, D. A., & Maxwell, S. E. (2003). Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling. *Journal of Abnormal Psychology*, *112*, 558–577. doi: 10.1037/0021-843X.112.4.558

Cramer, D. (1998). *Fundamental statistics for social research.* London: Routledge.

Cramer, D., & Howitt, D. (2004). *The SAGE dictionary of statistics.* London: SAGE.

De Castella, K., & Byrne, D. (2015). My intelligence may be more malleable than yours: The revised implicit theories of intelligence (self-theory) scale is a better predictor of

achievement, motivation, and student disengagement. *European Journal of Psychology of Education, 30*(3), 245–267.

Dinger, F. C., & Dickhauser, O. (2013). Does implicit theory of intelligence cause achievement goals? Evidence from an experimental study. *International Journal of Educational Research, 61,* 38–47. doi:10.1016/j.ijer.2013.03.008

Doane, D.P., & Seward, L.E. (2011). Measuring Skewness. *Journal of Statistics Education, 19*(2), 1-18.

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. New York, NY: Psychology Press.

Dweck, C. S. (2007). *Mindset: The new psychology of success*. New York, NY: Ballantine Books.

Dweck, C. S. (2015). Growth mindset, revisited. *Education Week.* Retrieved from http://www.edweek.org/ew/articles/2015/09/23/carol-dweck-revisits-the-growth-mindset.html

Dweck, C. S., & Bush E.S. (1976). Sex differences in learned helplessness: I. Differential debilitation with peer and adult evaluators. *Child Development, 12*(2), 147-156.

Dweck, C. S., Chiu, C. & Hong, Y. (1995a). Implicit theories and their role in judgments and reactions: A world from two perspectives. *Psychological Inquiry, 6*, 267-285. doi: 10.1207/s15327965pli0604_12

Dweck, C. S., & Leggett, E. L. (1988). A social cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256–273. doi:10.1037/0033-295X.95.2.256

Dweck, C. S., & Molden, D. C. (2017). Mindsets: Their impact on competence motivation and acquisition. In A.J. Elliot, C.S. Dweck, & D.S. Yeager (Eds,), *Handbook of competence*

and motivation, Second Edition, Theory and Application (135-154). New York, NY: Guilford Publications.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., et al. (1983). Expectancies, values and academic behaviors. In J. T. Spencer (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 75-146). San Francisco: W. H. Freeman.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*, 109-132.

Henderson, V. L., & Dweck, C. S. (1990). Achievement and motivation in adolescence: A new model and data. In S. Feldman & G. Elliott (Eds.) *At the threshold: The developing adolescent*. Cambridge, MA: Harvard University Press.

Hong, Y., Chiu, C., Dweck, C. S., Lin, D. M., & Wan, W. (1999). Implicit theories, attributions, and coping: A meaning system approach. *Journal of Personality and Social Psychology*, *77*(3), 588-599. doi:10.1037/0022- 3514.77.3.588

King, R.B. (2017). A fixed mindset leads to negative affect: The relations between implicit theories of intelligence and subjective well-being. *Zeitschrift für Psychologie, 225*(2), 137–145 DOI: 10.1027/2151-2604/a000290

Leondari, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived competence: Impact on students' achievement behavior. *Psychology in the Schools, 39*(3), 279–291. doi:10.1002/pits.10035

Martin, A. (2015). Implicit theories about intelligence and growth (personal best) goals: Exploring reciprocal relationships. *British Journal of Educational Psychology, 85*, 207-223. DOI:10.1111/bjep.12038

McCutchen, K. L., Jones, M. H., Carbonneau, K. J., & Mueller, C. E. (2016). Mindset and standardized testing over time. *Learning and Individual Differences, 45*, 208–213. doi:10.1016/j.lindif.2015.11.027

Mueller, C.M., & Dweck, C.S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology, 75*, 33–52.

Plaks, J. E., & Stecher, K. (2007). Unexpected improvement, decline, and stasis: A prediction confidence perspective on achievement success and failure. *Journal of Personality and Social Psychology, 93*(4), 667–684.

Robins, R. W., & Pals, J. L. (2002). Implicit self-theories in the academic domain: Implications for goal orientation, attributions, affect, and self-esteem change. *Self and Identity, 1*(4), 313–336.

Romero, C., & Master, A. (2014). Academic and emotional functioning in middle school: The role of implicit theories. *Emotion, 14*(2), 227-234. doi: 10.1037/a0035490

Shively, R. L., & Ryan C.S. (2013). Longitudinal changes in college math students' implicit theories of intelligence. *Social Psychology of Education, 16*, 241-256. DOI 10.1007/s11218-012-9208-0

Stipek, D., & Gralinski, J. H. (1996). Children's beliefs about intelligence and school performance. *Journal of Educational Psychology*, 88, 397- 407. doi:10.1037/0022-0663.88.3.397

Vargha, A., Torma, B., & Bergman, L. R. (2015). ROPstat: A general statistical package useful for conducting person-oriented analysis. *Journal for Person-Oriented Research, 1*(1-2), 87–98. doi:10.17505/jpor.2015.09

Weiner, B. (1972). Achievement attribution and the educational process. *Review of Educational*

Research, *42*(2), 203–215. doi:10.2307/1170017

Weiner, B. (1986). *An attributional theory of motivation and emotion*. New York: Springer-Verlag.

Wigfield, A., & Eccles, J. S. (2002). Children's motivation during the middle school years. In J. Aronson (Ed.), *Improving academic achievement: Contributions of social psychology*. San Diego, CA: Academic Press.

Yeager, D.S. & Dweck, C.S. (2012) Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist, 47*(4), 302-314, DOI: 10.1080/00461520.2012.722805

Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., . . . Dweck, C. S. (2016). Using design thinking to improve psychological interventions: The case of the growth mindset during the transition to high school. Journal of Educational Psychology, 108, 374-391. doi:10.1037/edu0000098

Table 1.1

Descriptive Statistics and Correlations

	M/%	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Wave 1: General Fixed Mindset	3.08	1.21	--	-.61***	.63***	-.54***	.57***	-.45***	.72***	-.52***	.55***	-.47***	.46***	-.51***	0.02	-0.05	0.05
2 Wave 1: General Growth Mindset	4.39	1.03		--	-.53***	.63***	-.60***	.67***	-.58***	.63***	-.41***	.50***	-.33***	.46***	-0.14	0.09	0.02
3 Wave 1: Course-specific Fixed Mindset in most	2.69	1.21			--	-.79***	.65***	-.50***	.64***	-.49***	.56***	-.53***	.37***	-.49***	0.05	-0.06	0.05
4 Wave 1: Course-specific Growth Mindset in most	4.73	1.02				--	-.65***	.71***	-.60***	.52***	-.49***	.55***	-.29***	.50***	-0.12	0.07	-0.01
5 Wave 1: Course-specific Fixed Mindset in easiest	2.47	1.22					--	-.73***	.56***	-.46***	.45***	-.48***	.44***	-.55***	0.1	-0.05	0.08
6 Wave 1: Course-specific Growth Mindset in easiest	4.84	1.04						--	-.49***	.47***	-.33***	.49***	-.31***	.55***	-0.15	0.14	-0.02
7 Wave 3: General Fixed Mindset	2.93	1.24							--	-.68***	.69***	-.55***	.59***	-.61***	0.05	0	-0.01
8 Wave 3: General Growth Mindset	4.46	1.05								--	-.52***	-.67***	-.45***	.64***	-.20**	0.11	-0.01
9 Wave 3: Course-specific Fixed Mindset in most	2.91	4.63									--	-.64***	-.46***	-.52***	-0.02	-0.04	-0.03
10 Wave 3: Course-specific Growth Mindset in most	4.63	1.05										--	-.42***	.77***	-0.06	0.17	0
11 Wave 3: Course-specific Fixed Mindset in easiest	2.72	1.27											--	-.63***	0.04	-0.07	0
12 Wave 3: Course-specific Growth Mindset in easiest	4.7	0.99												--	-0.1	.22**	-0.05
13 End of quarter GPA	3.17	0.65													--	-0.02	-0.04
14 Class level: Sophomore	64%	--														--	-0.12
15 Gender: Female	77%	--															--

Note. *p < .05, **p < .01, *** p < .001

Table 1.2

Wave 1 Item Analysis of Normality

	Skewness (SE)	Kurtosis (SE)
General Items		
General Fixed Mindset		
Item 1	0.41 (.21)	-.29 (.41)
Item 2	.57 (.21)	-.28 (.41)
Item 3	.26 (.21)	-.81 (.41)
General Growth Mindset		
Item 1	-1.01 (.21)	1.40 (.41)
Item 2	-.84 (.21)	.71 (.41)
Item 3	-.65 (.21)	-.19(.41)
Most Difficult Course		
Course-specific Fixed Mindset		
Item 1	-1.05 (.21)	.96 (.41)
Item 2	.78 (.21)	.19 (.41)
Item 3	.59 (.21)	-.40 (.41)
Course-specific Growth Mindset		
Item 1	-1.17 (.21)	1.92 (.41)
Item 2	-.70 (.21)	.37 (.41)
Item 3	-.85 (.21)	.81 (.41)
Easiest Course		
Course-specific Fixed Mindset		
Item 1	1.12 (.21)	.84 (.41)
Item 2	1.14 (.21)	1.25 (.41)
Item 3	.96 (.21)	.27 (.41)
Course-specific Growth Mindset		
Item 1	-1.40 (.21)	2.36 (.41)
Item 2	-1.49 (.21)	2.94 (.41)
Item 3	-1.25 (.21)	1.79 (.41)

Table 1.3

Wave 3 Item Analysis of Normality

	Skewness (SE)	Kurtosis (SE)
General Items		
General Fixed Mindset		
Item 1	.22 (.21)	-.99 (.41)
Item 2	.21 (.21)	-.98 (.41)
Item 3	.22 (.21)	-.93 (.41)
General Growth Mindset		
Item 1	-.59 (.21)	.22 (.41)
Item 2	-.69 (.21)	.27 (.41)
Item 3	-.50 (.21)	-.31 (.41)
Most Difficult Course		
Course-specific Fixed Mindset		
Item 1	.52 (.21)	-.42 (.41)
Item 2	.43 (.21)	-.38 (.41)
Item 3	.37 (.21)	-.53 (.41)
Course-specific Growth Mindset		
Item 1	-.84 (.21)	.84 (.41)
Item 2	-.53 (.21)	-.38 (.41)
Item 3	-.78 (.21)	.43 (.41)
Easiest Course		
Course-specific Fixed Mindset		
Item 1	.60 (.21)	-.29 (.41)
Item 2	.60 (.21)	-.27 (.41)
Item 3	.68 (.21)	-.15 (.41)
Course-specific Growth Mindset		
Item 1	-.54 (.21)	-.05 (.41)
Item 2	-.56 (.21)	.10 (.41)
Item 3	-.87 (.21)	.70 (.41)

Table 1.4

Confirmatory Factor Analysis: Standardized and Unstandardized Coefficients

Observed	Latent construct	b	*SE*	*B*	*SE*
Model 1					
Item 1	Fixed mindset	0.93	0.02	1	
Item 2	Fixed mindset	0.92	0.02	0.97	0.05
Item 3	Fixed mindset	0.81	0.03	0.95	0.07
Item 1	Growth mindset	0.68	0.05	1	
Item 2	Growth mindset	0.89	0.03	1.4	0.16
Item 3	Growth mindset	0.89	0.03	1.7	0.19
Model 2					
Item 1	Fixed mindset	0.89	0.02	1	
Item 2	Fixed mindset	0.96	0.01	1.1	0.06
Item 3	Fixed mindset	0.84	0.03	1	0.07
Item 1	Growth mindset	0.88	0.02	1	
Item 2	Growth mindset	0.98	0.01	1.2	0.06
Item 3	Growth mindset	0.9	0.02	1.1	0.07
Model 3					
Item 1	Fixed mindset	0.93	0.02	1	
Item 2	Fixed mindset	0.96	0.01	1	0.05
Item 3	Fixed mindset	0.9	0.02	1	0.06
Item 1	Growth mindset	0.93	0.01	1	
Item 2	Growth mindset	0.97	0.01	1	0.04
Item 3	Growth mindset	0.96	0.01	1	0.05
Model 4					
Item 1	Fixed mindset	0.89	0.02	1	
Item 2	Fixed mindset	0.96	0.01	1	0.05
Item 3	Fixed mindset	0.87	0.02	1	0.07
Item 1	Growth mindset	0.86	0.02	1	
Item 2	Growth mindset	0.95	0.02	1.2	0.07
Item 3	Growth mindset	0.89	0.02	1.2	0.08
Model 5					
Item 1	Fixed mindset	0.87	0.02	1	
Item 2	Fixed mindset	0.96	0.01	1.1	0.06
Item 3	Fixed mindset	0.9	0.02	1	0.07
Item 1	Growth mindset	0.93	0.02	1	
Item 2	Growth mindset	0.96	0.01	1	0.05
Item 3	Growth mindset	0.9	0.02	0.97	0.05
Model 6					
Item 1	Fixed mindset	0.96	0.01	1	
Item 2	Fixed mindset	0.91	0.02	0.95	0.05
Item 3	Fixed mindset	0.95	0.01	1	0.04
Item 1	Growth mindset	0.85	0.03	1	
Item 2	Growth mindset	0.95	0.02	1.2	0.08
Item 3	Growth mindset	0.91	0.02	1.2	0.08

Table 1.5

Summary of Repeated Measures Multivariate Analyses of Covariance (MANCOVA): General and Course-Specific Mindset Beliefs in Freshman and Sophomores at the Beginning and End of Quarter

Effects of the DVs	*SS*	*MS*	*df*	*F*	η^2_p
Combined Effects					
Time	--	--	6	2.71*	0.11
Class Level	--	--	6	1.44	0.06
Time*Class Level	--	--	6	0.44	0.02
Separate Effects					
General Mindset					
Fixed Mindset					
Time	1.7	1.71	1	3.94*	0.03
Time*Class Level	0.2	0.2	1	0.47	0.003
Error	58.23	0.43	135	--	--
Growth Mindset					
Time	0.28	0.28	1	0.684	0.01
Time*Class Level	0.04	0.04	1	0.11	0.001
Error	54.59	0.4	135	--	--
Hardest Class					
Course-Specific Fixed Mindset					
Time	2.91	2.91	1	4.37*	0.03
Time*Class Level	0.05	0.05	1	0.07	0.001
Error	89.87	0.4	135		
Course-Specific Growth Mindset					
Time	0.93	3.7	1	1.93	0.01
Time*Class Level	0.71	0.71	1	1.47	0.01
Error	65.04	0.48	135		
Easiest Class					
Course-Specific Fixed Mindset					
Time	4.27	4.27	1	4.89*	0.04
Time*Class Level	0.11	0.11	1	0.12	0.001
Error	65.04	0.48	135		
Course-Specific Growth Mindset					
Time	1.67	1.67	1	3.6	0.03
Time*Class Level	0.39	0.39	1	0.83	0.01
Error	62.7	0.46	135		

Note. Time is the independent variable. Each dependent variable is measured at two time points, at the beginning of the quarter and at the end of the quarter. Covariates included class level: freshman or sophomore. A dashed line indicates the measure was not included for the analysis. *SS* = sum of squares. *MS* = mean square. * $p < .05$

Table 1.6
Raw Means of General and Course-Specific Mindset Beliefs at Beginning and End of Quarter

	Beginning of Quarter	End of Quarter
Dependent Variable	*M (SD)*	*M (SD)*
General Fixed Mindset		
Freshman	3.15 (1.23)	2.93 (1.37)
Sophomore	3.03 (1.21)	2.92 (1.17)
General Growth Mindset		
Freshman	4.27 (1.19)	4.31 (1.17)
Sophomore	4.46 (.92)	4.55 (.97)
Hardest Course: Course-Specific Fixed Mindset		
Freshman	2.78 (1.36)	2.97 (1.21)
Sophomore	2.63 (1.11)	2.87 (1.25)
Hardest Course: Course-Specific Growth Mindset		
Freshman	4.62 (1.22)	4.40 (1.15)
Sophomore	4.78 (.88)	4.77 (.98)
Easiest Course: Course-Specific Fixed Mindset		
Freshman	2.55 (1.41)	2.85 (1.33)
Sophomore	2.43 (1.11)	2.65 (1.24)
Easiest Course: Course-Specific Growth Mindset		
Freshman	4.65 (1.27)	4.41 (1.11)
Sophomore	4.95 (.87)	4.87 (.88)

Table 1.7
Estimated Means from Repeated Measures MANCOVA of General and Course-Specific Mindset Beliefs at Beginning and End of Quarter

	Beginning of Quarter	End of Quarter	
Dependent Variable	*M (SE)*	*M(SE)*	Mean Difference *(SE)*
General Fixed Mindset	3.09 (.11)	2.92 (.11)	.16 (.08) *
General Growth Mindset	4.37 (.09) [a]	4.43 (.09) [a]	-.07 (.08)
Hardest Course: Course-Specific Fixed Mindset	2.71 (.11)	2.92 (.11)	-.21 (.10) *
Hardest Course: Course-Specific Growth Mindset	4.70(.09) [a]	4.58 (.09) [a]	.12 (.09)
Easiest Course: Course-Specific Fixed Mindset	2.49 (.11)	2.75 (.11)	-.26 (.12) *
Easiest Course: Course-Specific Growth Mindset	4.80 (.09) [a]	4.64 (.09) [a]	.16 (.09)

Note. Time is the independent variable. Each DV included measurements two time points, quarter beginning and quarter end. Covariates include class level (freshman or sophomore). Means are estimated after adjustment for the covariate. Read across each row, mean values with the same superscript denote no statistically significant difference at the two time points at the $p < .05$ level. Mean differences are calculated based on the differences between the measurements at the beginning of the quarter and the end of quarter. * $p < .05$

Table 1.8

Means of Growth Mindset and Fixed Mindset Clusters (General, Hardest Course, and Easiest Course) in Wave 1 and Wave 3

	Strong Growth Mindset Dominant		Moderate Growth Mindset Dominant		Strong Fixed Mindset Dominant		Moderate Fixed Mindset Dominant		Balanced		Balanced 2	
	GM	FM	GM	FM	GM	FM	GM	FM	GM	FM	GM	FM
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
Wave 1												
General Beliefs	5.42 (.50)	1.59 (.45)	4.60 (.58)	2.75 (.51)	2.26 (.57)	5.08 (.58)	--	--	3.92 (.70)	4.28 (.71)	--	--
Hardest Course	5.87 (.25)	1.42 (.46)	4.96 (.33)	2.26 (.36)	2.67 (1.07)	5.50 (.59)	--	--	4.07 (.55)	3.47 (.52)	--	--
Easiest Course	5.86 (.32)	1.15 (.30)	5.01 (.40)	2.20 (.39)	2.00 (.58)	5.62 (.49)	--	--	4.17 (.61)	3.56 (.59)	--	--
Wave 3												
General Beliefs	5.74 (.41)	1.35 (.42)	4.90 (.34)	2.28 (.43)	--	--	2.84 (.55)	4.77 (.46)	4.14 (.53)	3.67 (.53)	--	--
Hardest Course	5.83 (.35)	1.07 (.14)	5.26 (.49)	2.19 (.37)	--	--	3.41 (.92)	4.66 (.69)	4.43 (.57)	3.16 (.46)	--	--
Easiest Course	5.89 (.31)	1.03 (.09)	5.12 (.39)	2.22 (.38)	--	--	2.67 (.44)	4.90 (.50)	4.44 (.74)	4.35 (.71)	3.93 (.48)	2.83 (.38)

Note. Mindset beliefs were assessed on a scale of 1 = Strongly disagree to 6 = Strongly agree. GM is Growth Mindset. FM is Fixed Mindset. - - indicates that the cluster was not present for that particular construct.

Table 1.9

Linking of Clusters After Removal of a Residue (LICUR) Method: Chi-Square Analysis of Cluster Transitions Across an Academic Quarter

	n	Pearson Chi-Square (χ^2)	Degrees of Freedom (*df*)
General Mindsets	135	93.46***	9
Hardest Course Mindsets	136	77.19***	9
Easiest Course Mindsets	135	61.52***	12

Note. *** $p < .001$

Table 1.10

General Mindset Cluster Linkages Across an Academic Quarter

	Profile at End of Quarter				
General Mindsets	Strong Growth Mindset Dominant	Moderate Growth Mindset Dominant	Moderate Fixed Mindset Dominant	Balanced	**Total**
Profile at Beginning of Quarter					
Strong Growth Mindset Dominant	17 [a]	8	0	0 [b]	25
Moderate Growth Mindset Dominant	10	28 [a]	3 [b]	27	68
Strong Fixed Mindset Dominant	0	0	8 [a]	5	13
Balanced	0 [b]	4	8	17 [a]	29
Total	27	40	19	49	135

Note. Read across, each cell represents the number of students who started off in the row's profile at the beginning of the quarter and ended up in the column's profile at the end of the quarter. [a] Cells are statistically significantly overrepresented at the p = 0.0031 level, the adjusted p-value after a Bonferroni correction for *post hoc* cell-wise analysis. [b] Cells are statistically significantly underrepresented at the p = 0.0031 level, the adjusted p-value after a Bonferroni correction for *post hoc* cell-wise analysis.

Table 1.11

Hardest Course Mindset Linkages Across an Academic Quarter

	Profile at End of Quarter				
Hardest Course Mindsets	Strong Growth Mindset Dominant	Moderate Growth Mindset Dominant	Moderate Fixed Mindset Dominant	Balanced	**Total**
Profile at Beginning of Quarter					
Strong Growth Mindset Dominant	12:00 AM	15	3	3 [b]	33
Moderate Growth Mindset Dominant	6	21	2 [b]	19	48
Strong Fixed Mindset Dominant	0	0	9:00 AM	1	10
Balanced	0 [b]	7 [b]	16 [c]	22 [a]	45
Total	18	43	30	45	136

Note. Read across, each cell represents the number of students who started off in the row's profile at the beginning of the quarter and ended up in the column's profile at the end of the quarter. [a] Cells are statistically significantly overrepresented at the $p < 0.0031$ level, the adjusted p-value after a Bonferroni correction for *post hoc* cell-wise analysis. [b] Cells are statistically significantly underrepresented at the $p < 0.0031$ level, the adjusted p-value after a Bonferroni correction for *post hoc* cell-wise analysis. [c] Cells were trending toward being statistically significantly overrepresented.

Table 1.12

Easiest Course Mindset Linkages Across an Academic Quarter

	Profile at End of Quarter					
Easiest Course	Strong	Moderate	Moderate	Balanced 1	Balanced 2	**Total**
Profile at Beginning of Quarter						
Strong Growth Mindset Dominant	14 [a]	11	0	4	2	31
Moderate Growth Mindset Dominant	8	33 [a]	1	10	15	67
Strong Fixed Mindset Dominant	0	0	3 [a]	3	1	7
Balanced	2	4 [b]	6 [a]	8	10	30
Total	24	48	10	25	28	135

Note. Read across, each cell represents the number of students who started off in the row's profile at the beginning of the quarter and ended up in the column's profile at the end of the quarter. [a] Cells are statistically significantly overrepresented at the p = 0.0025 level, the adjusted p-value after a Bonferroni correction for *post hoc* cell-wise analysis. [b] Cells are statistically significantly underrepresented at the p = 0.0025 level, the adjusted p-value after a Bonferroni correction for *post hoc* cell-wise analysis.

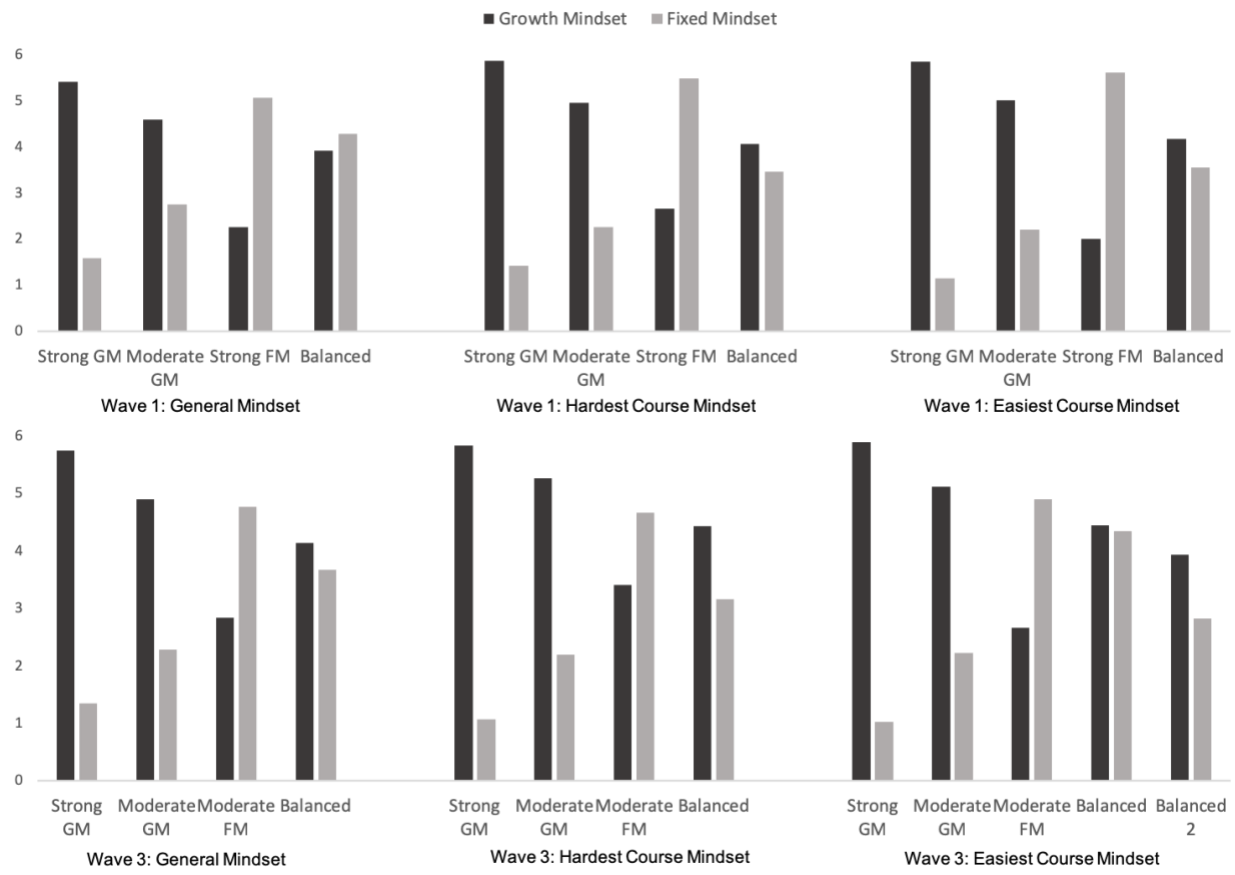


Figure 1.1. Final Ward's Method Cluster Solutions. Mean of growth mindset and fixed mindset beliefs for general mindsets, hardest course mindsets, and easiest course mindsets, across Wave 1 and Wave 3. Cluster names correspond to the profiles as described in the text.

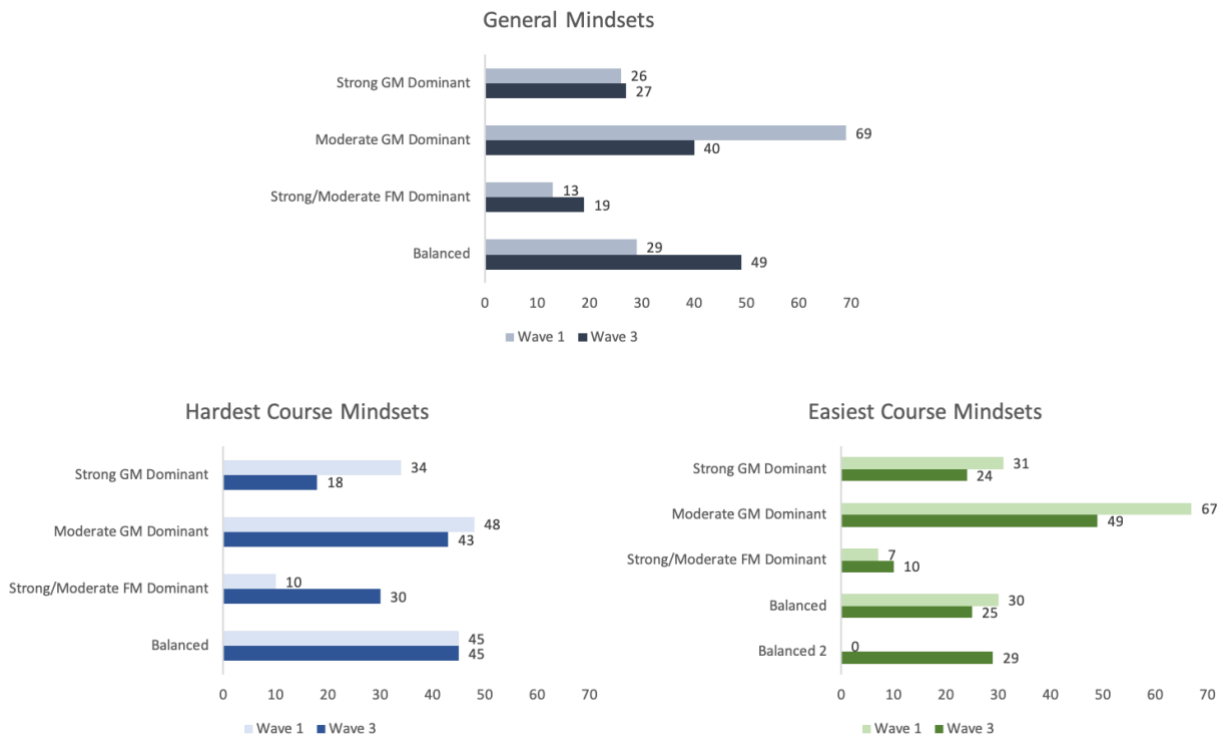


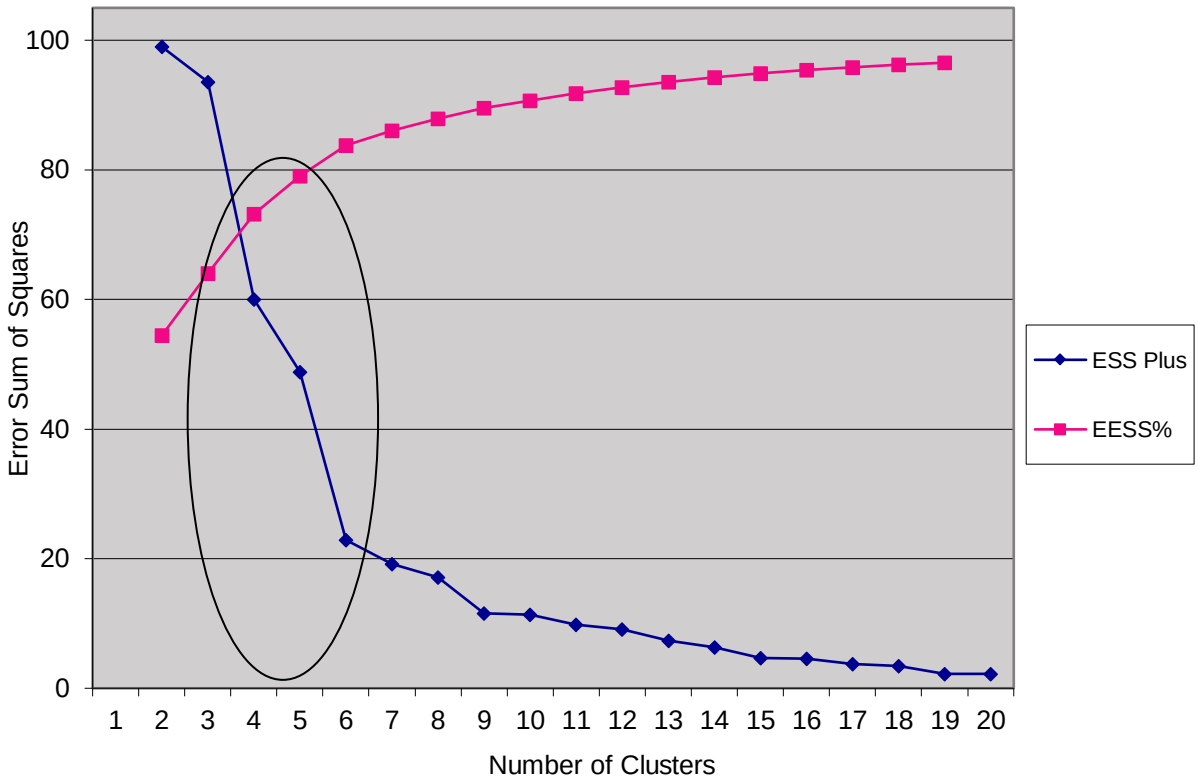
Figure 1.2. Summary of Cluster Membership. Number of students within each cluster profile at Wave 1 and Wave 3 for general mindsets, hardest course mindsets, and easiest course mindsets. Cluster names correspond to the profiles as described in the text

Appendix Figure 1.1

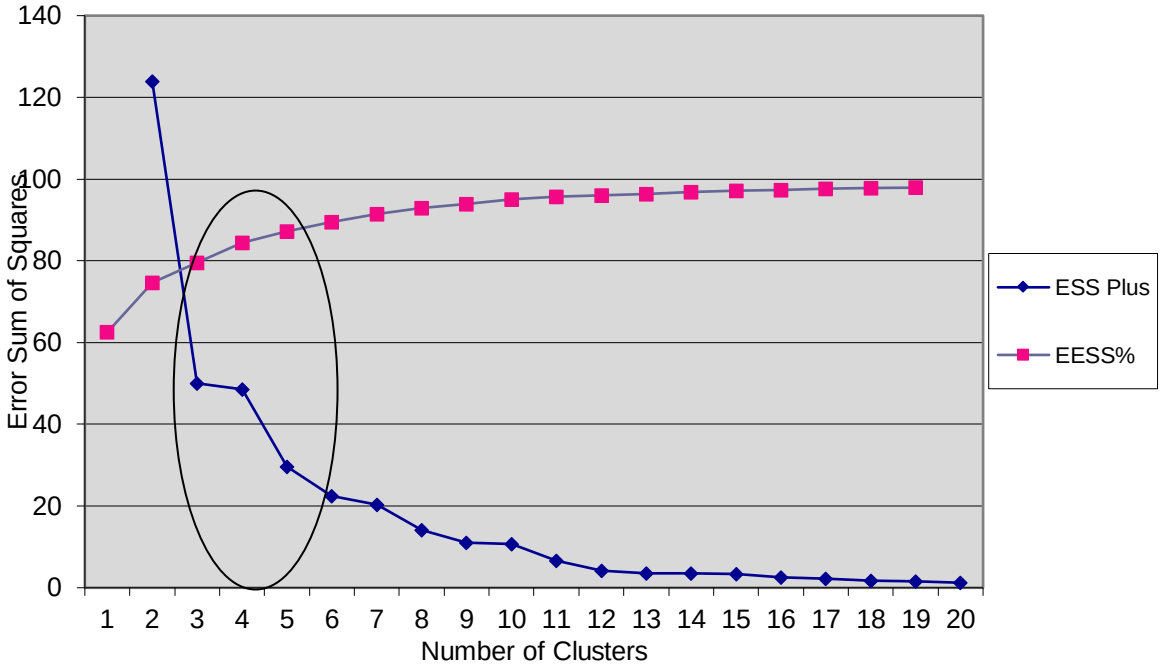
ESS Scree-type Plots Depicting Optimal Cluster Solutions

Six figures depict ESS Scree-type plots, illustrating an increase in error sum of squares (INC ESS) and explained error sum of squares (EXP ESS) by the number of cluster solutions. The oval illustrates the elbow in the plot that determined the optimal final solution for each type of pattern across two waves. Six cluster analyses were performed; thus, six plots were used to determine the optimal solution.

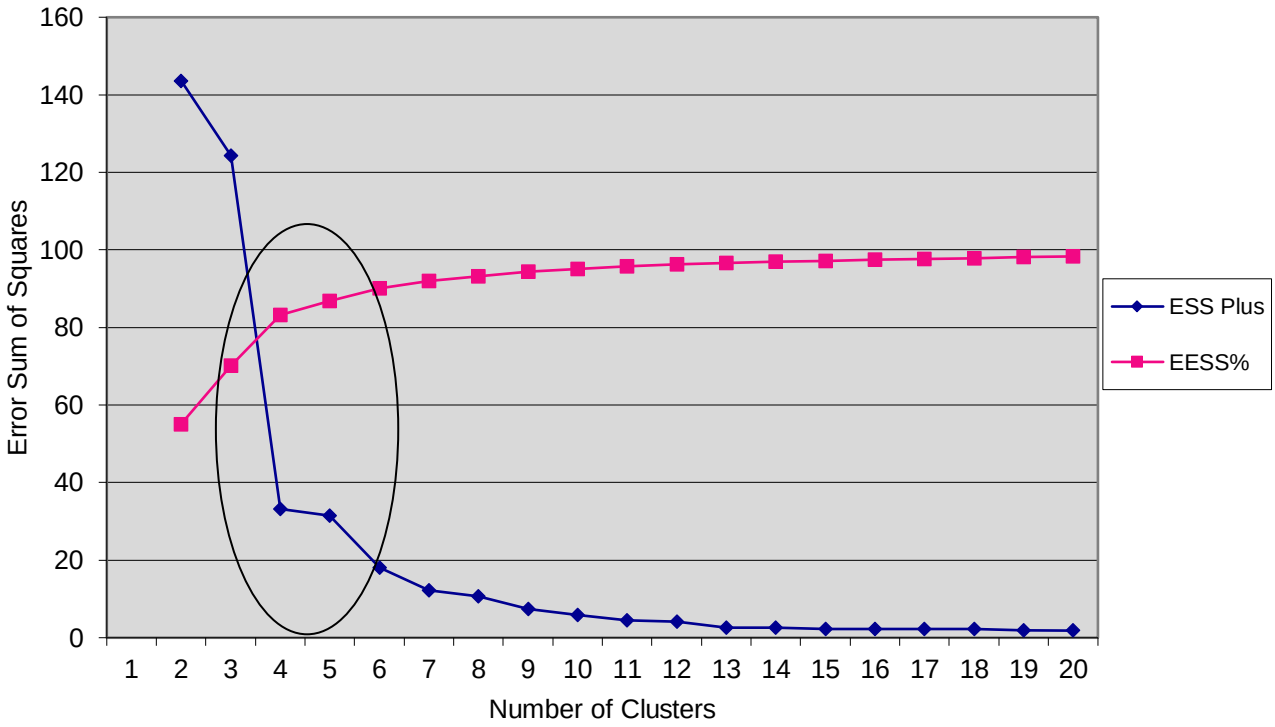
1. Wave 1 General Mindset Cluster Solutions



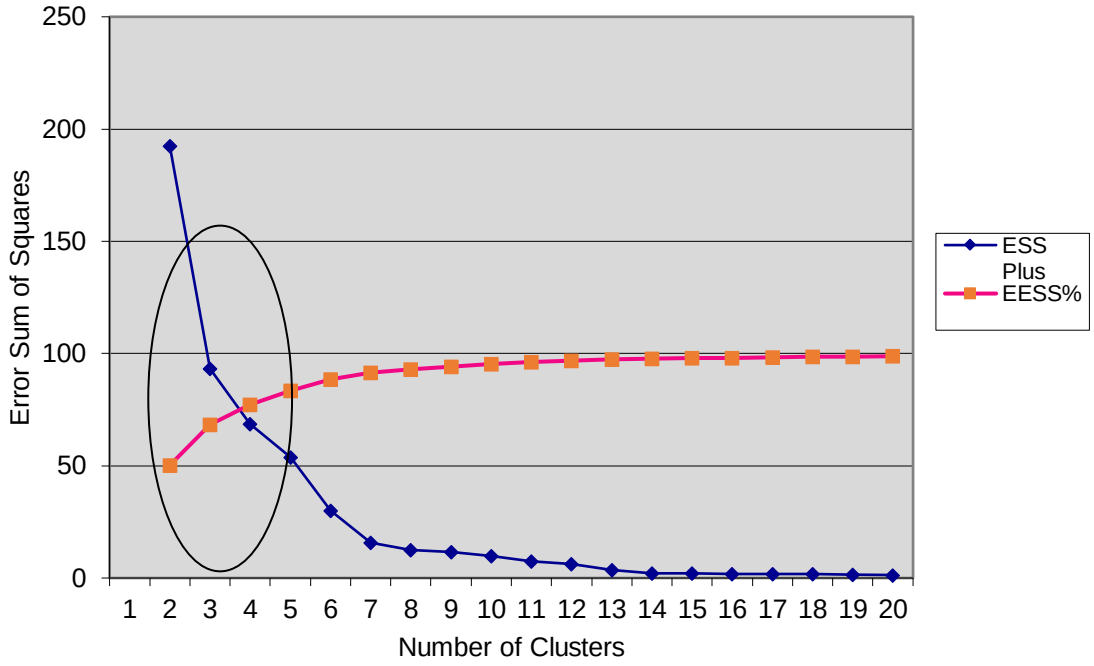
2. Wave 3 General Mindset Cluster Solutions



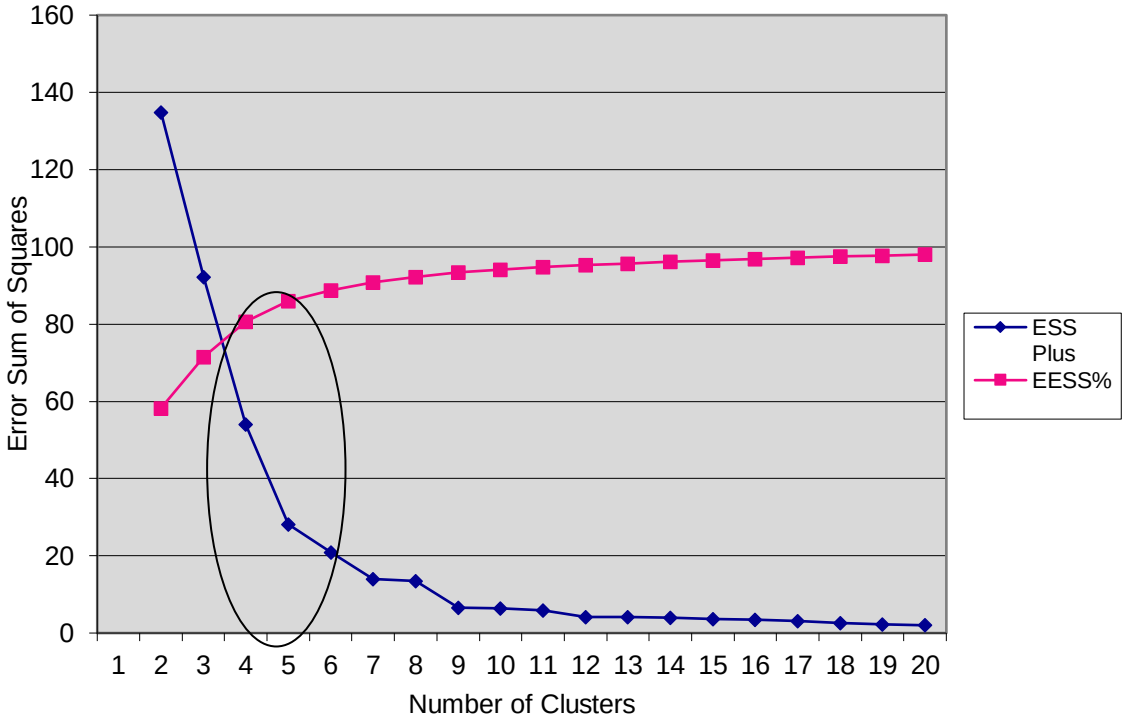
3. Wave 1 Easiest Course-Specific Mindset Cluster Solutions



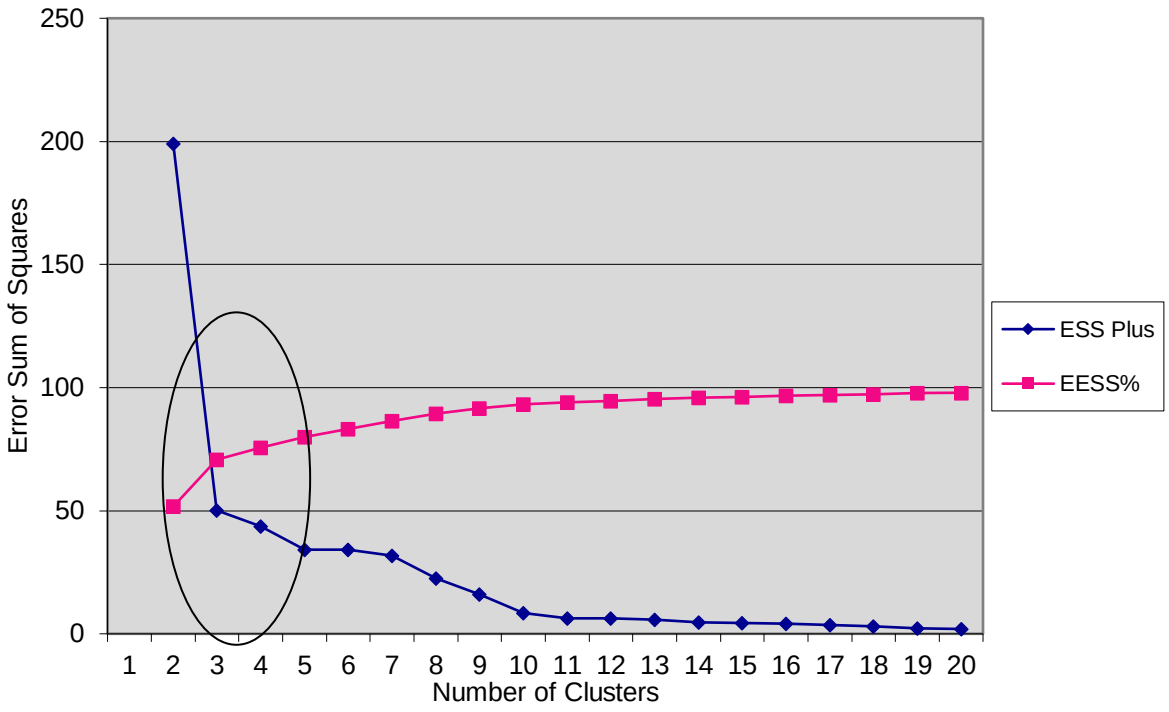
4. Wave 3 Easiest Course-Specific Mindset Cluster Solutions



5. Wave 1 Hardest Course-Specific Mindset Cluster Solutions



6. Wave 3 Hardest Course-Specific Mindset Cluster Solutions



Chapter 2: The Influence of Course-Specific Mindsets on Undergraduate Performance Attributions in a Challenging Course

Abstract

Mindsets and attributions have been understood as significant determinants of the learning process, performance, and motivation in the classroom; however, some researchers have recently questioned the extent to which mindsets truly impact student learning outcomes. More research is needed into which outcomes are actually influenced by specific mindsets beliefs. In the present study, we explore one possible route of influence through which mindsets may impact student learning: the relationship between course-specific growth and fixed mindsets to students' effort and ability attributions. We failed to find a relationship between students' mindsets and their causal attributions for course related success and failure; moreover, regardless of their mindset beliefs, most students moderately endorse effort-oriented explanations for their performance. Results indicated that overall, the effort and ability attributions students made in a challenging course context remained the same from mid-quarter to post-quarter, students with strong course-specific growth mindsets were not more likely to make more effort attributions for their midterm and final exams, and stronger fixed mindset beliefs were marginally statistically significantly related to weaker effort attributions at mid-quarter. The fact that none of the hypothesized relationships between mindsets and attributions emerged in the present study adds to the recent skepticism surrounding mindsets stemming from research findings that question the true impact of mindset beliefs and the efficacy of mindset interventions, perhaps suggesting mindsets may not be as closely related to student learning as previously championed.

Keywords: theories of intelligence, growth mindset, fixed mindset, attribution theory, undergraduate academic motivation, effort attributions, ability attributions

The Influence of Course-Specific Mindsets on Undergraduate Performance Attributions in a Challenging Course

Mindsets beliefs and causal attributions are considered important influences on learning, performance, and motivation in the classroom; however, some researchers have recently questioned the extent to which mindset beliefs truly impact student learning outcomes, particularly given recent failures to find significant associations between mindset beliefs and academic outcomes as well as between mindset interventions and changes in student achievement (Bahnik & Vranka, 2017; Education Endowment Foundation, 2018; Sisk, Burgoyne, Sun, Butler, & Macnamara, 2018) . For example, past research has found that students who endorse a general growth mindset are more likely to endorse effort-related attributions than students who endorse a fixed mindset (Hong et al., 1999), suggesting that attributions may be a possible belief system that may have a more direct influence on student achievement. The present study aims to understand how the holistic theories an individual endorses about their intelligence are related to the different types of causal explanations students' use to understand their academic performance, attempting to shed light on the true impact of mindsets on student learning. Specifically, I aim to understand how attributions develop over the course of a quarter, the extent to which course-specific mindsets uniquely explain and predict effort and ability attributions students make for their performance in their most challenging course, and how students' perceptions of their performance impact the relationship between students' mindsets and attributions.

Literature Review

Dweck's Mindset Theory and Weiner's Attribution Theory

The present study was designed to link two seminal perspectives on how students understand the malleability of their intelligence and the causal explanations of their academic performance. Dweck proposed two types of implicit theories about the nature of intelligence — an incremental theory (a growth mindset) and an entity theory (a fixed mindset). Having a growth mindset for intelligence means that an individual sees intelligence as something they can cultivate through effort and learning; if true, they should both attribute their successes and failures alike to their effort and be likely to persist in trying to master the challenging material as long as they value it (Dweck, 2000). Past research has heralded the growth mindset as the most adaptive and successful mindset (Blackwell et al., 2007; Dweck, 2000; Henderson & Dweck, 1990,), with Dweck encouraging students, parents, and teachers to take on a growth mindset in a myriad of life's domains (Dweck, 2007). Students with a growth mindset focus on learning leading to great academic achievement compared to students with fixed mindsets (Yeager & Dweck, 2012). Previous studies have shown that students with a growth mindset have a higher level of determination (Blackwell et al., 2007; Stipek & Gralinski, 1996), which when coupled with a greater focus on learning, may lead to decrease in the rate of decline in achievement. Students with a growth mindset are more confident in their ability to change their future academic outcomes through studying or increased efforts compared to students with a fixed mindset; therefore, they are more likely to take measures to learn the information needed to do well (Mueller & Dweck, 1998; Plaks & Stecher, 2007).

Having a fixed mindset for intelligence means that an individual sees their intelligence as reflecting a fixed amount of talent that is immutable, thus they attribute their negative academic

outcomes to lack of talent, and they do not think they can do much to alter their fixed amount of intellectual aptitude (Dweck, 2000). Such an attribution will lead to low expectations for future success, self-doubt, and giving up in the face of failure (Dweck, 2000; Plaks & Stecher, 2007; Weiner, 1986). Past research has supported the negative consequences of a fixed mindset (Hong et al, 1999; Henderson & Dweck 1990; Dweck, 2000). Furthermore, Dweck (2000) urges parents to never praise children using "person" praise—that is, saying they are a good girl or a smart girl when they do well on a task—and to instead use "process" praise and celebrate the effort and learning process their child experienced. Advocates of mindset theory argue that focusing on stable factors such as intelligence or talent as the causes of performance lead people to become highly concerned with measuring and validating their intelligence, often to the detriment of learning. People interpret their setbacks as a reflection of their underlying incompetence and exhibit defensive or ineffective strategies in the face of challenges or threats to their intelligence (Blackwell et al., 2007; Dweck & Molden, 2017). Dweck and colleagues argue that students with attributions focused around their ability will end up viewing working hard as reflections of their deficient ability. Students with a fixed mindset tend to excel as long as the information comes easily for them, but their achievement lessens when they are faced with academic challenges or setbacks (Mueller & Dweck, 1998).

Dweck and her associates (Dweck, Chiu, & Hong, 1995a; Dweck & Leggett, 1988) argued that people's implicit theories about intelligence leads them to certain behaviors, such as choosing to study more in the hopes of improving their grades if they have a growth mindset. Thus, causal attributions may be a likely mediator between mindset beliefs and students' reactions to academic feedback, especially when something is challenging. According to Dweck's model of implicit theories (Dweck & Leggett, 1988) and attribution theory (Weiner,

1972), a person with a fixed mindset would understand the causes for their academic failures to be rooted in something unchangeable, causing them to think there is nothing they can do to increase their intelligence. This may eventually cause a decline in motivation-related beliefs, such as in subjective task value (the qualities of the task that increase the chances of choosing the task) and self-concept of ability, leading to the devaluing of the subject, a lessened belief that one is good at the subject, and an increase in believing that they cannot change their ability through effort (Dweck, 2000; Weiner, 1986; Henderson & Dweck, 1990; Wigfield & Eccles, 2002). On the other hand, students who endorse a growth mindset are less likely to doubt their ability to succeed in the face of failure and are more prepared to respond to failure with increased effort, which may be the reason they experience higher academic achievement (Henderson & Dweck, 1990), lending evidence to the protective quality of a growth mindset against declines in motivation-related beliefs and achievement. Thus, when students with a growth mindset are faced with challenges, they are more likely to believe they have the power to improve their abilities through increased effort, which may result in greater valuing of the subject when the positive associations with their success become associated with their strong efforts (Eccles et al., 1983). However, attributing success to stable factors is also adaptive and leads to higher performance because these students feel more pride in their successful accomplishments, increasing the likelihood that subsequent actions toward achievement will be initiated (Weiner, 1972, Eccles & Wigfield, 2002). Thus, students with a growth mindset may give a shared importance to both effort and ability when thinking about the causal roots of their successes.

In his causal attribution theory, Weiner (1972) argued that achievement related causal attributions influence whether students persist or give up after academic failures (Weiner, 1986; Weiner & Kukla, 1970). Weiner identified ability, effort, task difficulty, and luck as the most

important factors that affect achievement attributions. Furthermore, attributions are classified along three causal dimensions: locus of control (internal versus external), stability (stable versus unstable), and controllability (uncontrollable versus controllable) (Weiner, 1974). In the current study, we focus on two factors—ability and effort. Students with higher achievement and greater confidence in their abilities tend to attribute their successes to internal, stable, and uncontrollable factors such as ability and attribute their failures to internal, unstable, controllable factors such as effort (Weiner, 1974). Attributing failures to unstable factors such as effort allows the person to believe they have volitional control and can increase or decrease their effort on future occasions. In a similar vein, Dweck and her associates (Dweck et al., 1995a; Dweck & Leggett, 1988) champion effort-focused thinking and process-oriented learning. They argue that people's implicit theories about themselves guide them to partake in certain behaviors and cause them to make certain causal attributions about their academic successes and failures.

Relationship Between Course-Specific Mindsets and Attributions

Attributions are significant influences on learning, performance, and motivation in the classroom because the amount someone strives for achievement is influenced by the causes they use to explain their successes and failures (Weiner, 1986). In his causal attribution theory, Weiner (1972) argued that achievement-related causal attributions have a major influence on whether students persist or give up after academic failures (Weiner, 1986; Weiner & Kukla, 1970), and this impact may be even greater during times of major life transitions such as entering college. Schulz and Heckhausen (1999) argue that the attribution process plays a more crucial role during freshman year when students are transitioning from high school to the novel environment of college. Weiner's attribution theory suggests that the causal factors that students use to interpret their academic performance may influence their motivation and subsequent

performance. Individual differences in achievement are related to differences in attributions (Weiner, 1986), making it essential that we study individual attribution patterns. Furthermore, past research has shown that specific attributions mediate the relationship between general mindsets and many achievement-related outcomes, but it is unclear how context-specific mindsets are related to context-specific attributions. For example, students with a fixed mindset have been found to be less likely to make effort attributions than students with a growth mindset, even in the face of failure and negative feedback (Hong et al., 1999), but only students' general mindsets about intelligence were assessed. Hong et al. (1999) also found that effort attributions mediated whether students whose mindsets were induced by reading either fixed mindset or growth mindset articles took remedial action when given unsatisfactory feedback on a task, indicating that mindsets and attributions are linked.

However, we do not know much about the extent to which personal and domain-specific mindsets map onto individual's causal explanations for their performance in specific domains. Only one study has looked at the extent to which self-theory mindsets (e.g. "*My* intelligence has the potential to change over time.") map onto real-world achievement attributions. Robins and Pals (2002) found that college students with self-theory fixed mindsets were more likely to endorse uncontrollable factors such as ability for their failures and luck for their successes. Those with growth mindsets regarding their own intelligence attribute success and failures to internal and controllable factors like effort and study skills, indicating a relationship between general self-theory mindsets and personal causal attributions. It could be possible that self-theory domain-specific mindsets have an even closer link to domain-specific attributions because they both involve thinking about one's own performance in a specific academic context.

The relationship between students' mindset beliefs and causal attributions can be further influenced by the difficulty of the course material, but this has seldom been explored. Students' specific perceptions of their courses—for example, whether they are challenging for them—may influence their causal attributions and mindsets for those courses, making them different for more challenging contexts. Most studies have explored the extent to which single causal attributions impact achievement and motivation (Ablard, 2002; Blackwell, Trzesniewski, & Dweck, 2007; Diener & Dweck, 1980; Hong et al., 1999; Leondari & Gialamas, 2002; Romero & Master, 2014), but because students likely endorse multiple types of attributions (e.g., effort, ability, luck, help from others) when understanding the causes for their academic performance, existing studies provide a limited story, creating a need for more studies to provide a more comprehensive understanding of the extent to which individuals' multiple causal attributions relate to their mindset beliefs in different types of learning environments.

Skepticism About the True Impact of Mindsets

The majority of mindset studies, including interventions, have looked at the relationship between endorsing a particular mindset and subsequent achievement scores. The mindset interventions were based on the idea that implementing a growth mindset will increase students' academic achievement. While the popularity of mindset interventions has soared (Paunesku et al., 2015; Yeager, Romero et al., 2016; Yeager, Walton et al., 2016), with many school settings readily paying thousands of dollars to implement mindset interventions into their curriculum, many studies have failed to replicate the success of the original mindset studies that claimed teaching students to have a growth mindset resulted in higher grades. However, recent findings that mindset beliefs have no relationship with academic outcomes and that mindset interventions have no impact on increasing achievement scores (Bahnik & Vranka, 2017; Education

Endowment Foundation, 2018; Sisk et al., 2018)), cast a shadow of skepticism over the real impacts of mindsets. It is becoming more and more unclear whether attempts to change students' mindsets about their abilities and intelligence have any positive effect on their learning at all (Hendrick, 2019). It may be possible that global beliefs about intelligence have little impact on students' actual performance because these beliefs are too far removed from the day-to-day occurrences that students experience in their courses. We might expect that domain-specific beliefs about intelligence may be more closely related to performance in a given domain, but this has seldom been explored.

Although the growth mindset appears to be a viable construct in the lab, as evidenced by numerous studies by Dweck and colleagues since the 1980s, it may not work at scale when administered in the classroom via targeted interventions. What is also troubling is that many studies fail to find any existing relationship between the mindsets held pre-intervention and their achievement, indicating that whether or not a mindset is altered via intervention, the impact on student learning will still not be there. For instance, Bahnik and Vranka (2017) found that, in a large sample of Czech university students, the relationship between academic achievement and growth mindset was slightly negative; they concluded that the strength of the association between academic achievement and mindset might be weaker than previously thought. They had expected, but did not find, that students who had growth mindsets would be more likely to take more administrations of the test in order to improve their scores. Furthermore, a growth mindset did not predict improvement in test scores. Results from two meta-analyses indicated a very weak relationship between mindsets and academic achievement (Sisk et al., 2018). Furthermore, there was little to no effect of mindset interventions on academic achievement for the majority of

students; however, Sisk et al. (2018) found that students with low SES backgrounds or who were academically at risk benefited more from mindset interventions than other groups.

Given the issues of replication surrounding the mindset theories, we may wonder what mindsets actually impact, if there is no direct impact on students' achievement. It is possible that mindsets impact other types of beliefs students have about their academic abilities and successes, which in turn may influence students' achievement. Intelligence beliefs may be related to other more salient belief systems that students face every day in the classroom or in their interaction with course materials. For example, students may not spend a considerable time thinking about growing their intelligence in a course compared to how often they think about how much they need to study to retain enough material in order to increase their grades. Causal attributions may be one such belief system that is related to an individual's global beliefs about intelligence, but more closely related to students' actual performance because students use information gleaned from their course experiences to make their causal attributions. Believing that their intelligence is malleable with the potential to grow may make an individual more likely to believe that the more effort they expend learning and studying the material, the better their performance will be. Students with growth mindsets might also be just as likely to attribute their successes and failures to their talents or abilities, believing that their efforts would have increased their intelligence in the particular subject domain. On the other hand, believing that their intelligence is fixed and innate may make an individual less likely to believe that their effort has anything to do with their performance. Students with fixed mindsets may be more likely to attribute their successes and failures to their natural ability, intelligence, or talent more than their efforts.

The Present Study

In the face of many mixed findings regarding the impact of mindsets on student achievement, perhaps taking a step back to understand what beliefs, such as causal attributions, are related to our intelligence mindsets is a good first step. Utilizing analysis of covariance techniques and hierarchical linear regression, the present study will explore how course-specific attributions for students in challenging course context develop between students' midterm and final exam, the relationship between course-specific attributions and course-specific mindsets, and how this relationship is influenced by students' perceptions of their performance in their hardest course.

Research Questions

1) To what extent do effort causal attributions change over the course of a quarter? If they do change, is this change related to initial growth mindset beliefs?
2) To what extent does having a growth mindset lead to stronger effort causal attributions in a challenging course context?
3) To what extent do ability causal attributions change over the course of a quarter? If they do change, is this change related to a fixed mindset?
4) To what extent does having a fixed mindset lead to stronger ability attributions in a challenging context?
5) To what extent is the perception of whether one has done well in their courses associated with students' mindsets and attributions?

Hypothesized Results

I hypothesize that having a course-specific growth mindset leads to stronger effort causal attributions for one's course performance and having a course-specific fixed mindset leads to stronger ability causal attributions and weaker effort causal attributions. In a challenging course

context, students' specific mindsets and attributions may be dependent on their perceptions of how well they feel they have done in their courses. For example, students who believe they are doing well in their courses and have a growth mindset may strongly believe in their successes are due to their efforts and abilities. Students who believe they are doing poorly and have a growth mindset, may believe that their poor performance is due to their lack of effort. Students who are doing well and have a fixed mindset may have strong ability attributions for their successes. Moreover, if students with a fixed mindset believe they are not doing well in their courses, the negative feedback from their course performance may reinforce their belief that they cannot improve their abilities in the course leading to stronger ability attributions and weaker effort attributions. However, given the recent findings indicating perhaps a lack of relationship between mindset and student achievement outcomes, it is important to note that mindsets may not be as influential on academic outcomes as previously thought.

Methods

Design

In the fall of 2017, a total of 177 undergraduate students were recruited to join the nine-month longitudinal study entitled The Early College Motivation Project. Participants were recruited after the lead researcher visited several undergraduate classes during Week 0-2 of fall quarter. Students were recruited from two biology courses and three education courses in order to recruit students with a variety of majors. Surveys were administered online three times during each quarter for one academic year (three academic quarters). During each quarter, Wave 1 occurred before participants' midterm exam (Week 3-5), Wave 2 occurred after participants' midterm exam (Week 7-9), and Wave 3 occurred after final exams during the holiday break following the end of the quarter. Participants had two to three weeks to complete each survey.

They were compensated for each survey the day after survey was due. The present study utilizes data only from the second and third wave of the study.

Procedure and Participants

The lead researcher visited classes to give a brief presentation about the study to recruit interested freshmen and sophomores. Two classes were in the Biological Sciences department (n=618) and three classes were in the Education department (n=355) in order to recruit students with varied majors. The biological sciences classes were non-major courses that are open to anyone at UCI. Two of the education courses were major requirements for education science majors and one was an elective. Students listened to a brief presentation about an overview of the study, eligibility requirements, and compensation. The total number of enrolled students in the five classes was approximately 973 students. Of the 973 students who were presented with the opportunity to join the study, 336 students expressed interest in the study. Interested students signed up on a sign-up sheet and were contacted within a few days with a recruitment survey that allowed them to read the consent form and consent to joining the study. 177 students of the 183 students who completed the recruitment survey were eligible for the study (e.g., they were freshman or sophomores and above age 18), yielding a total recruitment rate of 18%. In the final sample, 48.6% students were recruited from Bio Sci 35: Brain and Behavior, 29.9% were recruited from Bio Sci 36: Drugs and the Brain, 14.1% students were recruited from Education 50: Issues in K-12 Education, 6.8% were recruited from Education 10: Research Design, and 0.6% were recruited from Education 55: Knowledge and Learning in Math and Science. Students received a personalized link to their first survey during Week 3 of the fall quarter. Students were automatically reminded via email to complete the survey if they had not completed it within

seven, ten, and thirteen days of the allotted two-week period. All subsequent surveys were sent via personalized link to students every 3 to 4 weeks.

Analysis Sample Characteristics

The present study included 135 participants from the original cohort of 177 participants. 32 participants were excluded because they did not complete both Wave 2 and Wave 3 of data collection. The average age of participants in the subsample is 18 years and 8 months old. 76% of the sample was female. The ethnic breakdown of the subsample closely matches the overall sample of UCI students (51% Asian, 26% Hispanic/Latino, 10% White, 2% Black, 5% Multiracial-White and Asian, 3% Multiracial-White and Hispanic/Latino, 2% Multiracial-other, and 1% Middle Eastern). 14% of the sample are international students and 56% of students are first generation college students. These numbers are comparable to UCI overall, where 47% of newly enrolled students were first-generation students and 17% of the student body are international students in 2017. 50% of the subsample was designated by university records as low-income. Of the 93% of students who reported their parents' highest level of education, 13% reported one or more parent had less than a high school education, 22% graduated from high school, 10% attended college but did not graduate, 4% attended vocational/technical school, 6% obtained their associate's degree, 26% obtained their bachelor's degree, 15% obtained their master's degree, and 5% obtained an advanced or professional degree. Students' major selections varied in the subsample with 33% choosing a social sciences/social ecology major, 17% education, 4% humanities, 4% computer science, 4% business, 4% public health, 2% engineering, 2% biological/physical sciences, 2% fine arts, 1% pharmaceutical science, and 27% were undeclared/unaffiliated.

Measures

All measures were pilot tested with former undergraduate students for clarity. Students course-specific growth mindset and fixed mindset in their hardest course were measured. Students were asked to specify their hardest course in the first survey of the quarter. Their responses were automatically filled into subsequent surveys; however, during the mid-quarter survey, students were asked to confirm that they were still enrolled in the courses that they specified. If they had dropped the first course they specified, they were asked to specify their new hardest course. This response was then automatically inserted into the final survey. In the final survey, it was assumed that students could no longer drop any of their courses because all drop periods had ended before the mid-quarter survey. Thus, the survey did not account for students changing their mind about what course was their hardest and only took into account that they were still enrolled in the class they had specified at the beginning. Only three students dropped their initially reported hardest course. 134 out of 135 students specified their most difficult course: 24% chose a humanities course, 21% chose a biological sciences course, 19% chose a class from the social sciences, 11% chose a math course, 6% chose a social ecology course, 4% chose an information and computer sciences course, 4% chose a physics course, 3% chose an education course, 3% chose a chemistry course, 2% chose a public health course, 2% chose a business course, and 1% chose an earth system science course. See Figure 2.1 for a summary of when each measure used in analysis for the present study was collected.

Course-specific mindset scales in the hardest course. The course specific personal versions of the mindset scales were based on the original measure by Dweck and colleagues (Dweck, 2000). De Castella and Byrne (2015) revised the original mindset scale to create a self-theory scale in which the original items were re-worded so that each statement reflect a first-

person claim about the extent to which intelligence was fixed or malleable. I further revised the self-theory scale to make each statement specific to the most difficult course, as specified by the student. Efforts were made to ensure that the items aligned closely with the original mindset items. Students were told to rate the extent to which they agreed with each statement on a Likert scale of 1-6 (1 = *Strongly disagree*; 6 = *Strongly agree*). The Wave 2 (mid-quarter) course-specific mindsets will be used for analysis.

Growth mindset in the hardest course. The growth mindset scale contains three items that indicate how much a student believes in the malleability of their own intelligence in their most difficult course (e.g., "Regardless of my current intelligence level in this course, I think I have the capacity to change it quite a bit"). Strong agreement with this scale would indicate that a student believes they can change their own intelligence in a specific course. (1= *Strongly disagree* to 6 = *Strongly agree*; $\alpha = .95$).

Fixed mindset in the hardest course. The fixed mindset scale contains three items that indicate how much a student believes in the fixedness of their own intelligence in their most difficult course (e.g., I can learn new things in this course, but I don't have the ability to change my basic intelligence in this course). Strong agreement with this scale would indicate that a student believes their own intelligence is fixed in a specific course. (1= *Strongly disagree* to 6 = *Strongly agree*; $\alpha = .90$).

Attributions. Students were asked to consider how important a causal factor was in determining their performance on their midterm and final exam in their most difficult course. Items were adapted from previous attribution measures (Elig & Frieze, 1979). Students were asked to respond on a 5-point Likert scale, ranging from 1 (not at all important) to 5 (very important). Attributions about students' performance on their midterm and final exam in their

most difficult course were assessed during the second and third time point of each quarter. Six causal statements were presented to students after they rated how well they felt they did on their midterm/final exam of their most difficult course (e.g., "You indicated that you did very well/well/fair/poor/very poor on your midterm of your most difficult course. Please indicate how importance the following reasons were for your performance."). The items belonged to two causal categories: effort and ability.

Effort attributions. Three items reflected causal statements regarding how much effort the student put forth for the midterm/final. The items were: "The amount of effort you put into studying the course material," "The amount of time you spent studying the course material," and "How hard you worked in the course," (Wave 2: $\alpha = .80$; Wave 3: $\alpha = .77$).

Ability attributions. Three items reflected causal statements regarding how much ability or intelligence the student possessed. The items were: "The amount of talent you have in the subject matter," "The amount of intelligence you have," and "The amount of academic ability of skill you have in this course," (Wave 2: $\alpha = .80$; Wave 3: $\alpha = .74$).

Perceptions of Performance. Students were asked to consider how well they felt they performed on the midterm and the final exam of their hardest course during the second and third survey. A single item asked, "How well do you feel you did on the first exam or midterm/ final exam in your most difficult course?" Students rated their response on 5-point Likert scale, ranging from 1 (very poor) to 5 (very well). Perceptions of midterm performance was collapsed into three subgroups: poor, fair, and well, with "poor" indicated by scores of 1 (very poor) and 2 (poor), "fair" indicated by a score of 3, and "well" indicated by scores of 4 (well), and 5 (very well). Regarding their midterm exam, 24% indicated they performed poorly, 31% indicated they performed fairly, and 45% reported they performed well. Regarding their final exam, 16% of

students indicated they performed poorly, 36% reported they performed fairly, and 48% of students indicated they performed well. Because students had varying levels of perceptions surrounding the attributions they made for the midterm/final exams, performance perceptions were utilized to understand if students with differing perceptions endorsed different types of mindsets and attributions.

Analysis Plan

Confirmatory factor analysis (CFA). I used CFA to verify the factor structure of the course-specific mindset scale, effort attributions, and ability attributions. Given that the course-specific mindset scale is an adaptation of the well-established mindset scale developed by Dweck and colleagues, it was important to test the hypothesis that the underlying latent constructs of a growth mindset and fixed mindset exist for the adapted scales. The attribution items have been adapted from previous measures. Given that students may understand terms such as ability and talent differently, it was essential to make sure that each scale is measuring the intended construct. Structural equation modeling was used, relying on several statistical tests to determine the adequacy of the model fit to the data (e.g., chi-square test, comparative fit index, and RMSEA).

Bivariate correlations. I used bivariate correlations as a preliminary exploration of how course-specific growth mindsets and course-specific fixed mindsets relate to the two types of attributions.

Multivariate analysis of covariance. MANCOVA was used to test for significant within-subject differences in effort and ability attributions at mid-quarter and end-of-quarter. The independent variable was time. The dependent variables were effort attributions and ability attributions regarding their performance on their midterm and final exam. I tested for the effect

of an interaction between time and each attribution construct in order to understand whether effort and ability attributions are likely to change from the middle of the quarter to the end of the quarter. Covariates included class level.

Hierarchical multiple regression analyses. I used separate regression analyses of the associations of the mid-quarter predictors (course-specific growth mindset, course-specific fixed mindset, and exam (midterm or final exam) performance perceptions) to mid-quarter dependent variables (effort attributions and ability attributions) and to post-quarter dependent variables (effort attributions and ability attributions). The primary purpose of these analyses was to determine to what extent course-specific mindsets and performance perceptions uniquely explained and predicted effort and ability attributions cross-sectionally and over the quarter.

Handling Missing Data

No one in the analysis sample was missing data on any of the key mindset variables. Listwise deletion occurred for less than 1% of participants who were missing data on the attribution variables. Listwise deletion was used in this case because it introduces the smallest amount of bias. Thirty-two participants were excluded because they did not complete surveys for both Wave 2 and Wave 3. Independent-samples t-tests and chi-square test for independence determined that those individuals who were dropped from the analysis sample did not significantly differ from those with complete data on demographic or university data. Independent-samples t-tests were conducted to compare the end of quarter GPA and age for those missing data and those with complete data. There was no significant difference in end of quarter GPA (on a scale of 0 to 4.0) for those who were missing data (M = 2.95, SD = .82) and those who had complete data (M = 3.17, SD = .65); t (165) = -1.68, p = .10 (two-tailed). The magnitude of differences in the means (mean difference = -.22, 95% CI: -.49 to 0.04) was small

(eta squared = 0.02). There was no significant difference in age for those who were missing data (M = 18.68, SD = .63) and those who had complete data (M = 18.63, SD = .57); t (155) = .40, p = .69 (two-tailed). The magnitude of differences in the means (mean difference = .05, 95% CI: -.20 to .30) was very small (eta squared = 0.001). Chi-square tests for independence (with Yates Continuity Correction) indicated no significant associations between students who are missing and students who have complete data on the following variables: gender, χ^2 (1, n = 167) = 1.03, p = .31, phi = -.10; class level, χ^2 (1, n = 167) = .11, p = .74, phi =.04; low-income status, χ^2 (1, n = 167) = 0, p = 1, phi = -.003; international student status, χ^2 (1, n = 167) = .15, p = .70, phi = -.05; and college generation status, χ^2 (1, n = 163) = 1.03, p = .31, phi = -.10. Chi-square tests for independence also indicated no significant associations between missing status and: race/ethnicity, χ^2 (7, n = 157) = 5.06, p = .65, phi =.18; highest level of parent's education, χ^2 (7, n = 149) = 14.01, p = .051, phi = .31; and college major, χ^2 (13, n = 161) = 15.41, p = .28, phi = .31.

Results

Descriptive Summary

I examined the key mindset and attribution variables at a descriptive level. Means were skewed downward for course-specific fixed mindset (M = 2.81, SD = 1.13) and skewed upward for course-specific growth mindsets (M = 4.64, SD = 1.05). On average, students made stronger effort attributions (Wave 2: M = 4.08, SD = .78; Wave 3: M = 4.08; SD = .76) than ability attributions (Wave 2: M = 3.11, SD = .95; Wave 3: M = 3.10; SD = .86) at both time points. A correlation matrix for the key variables and covariates is provided in Table 2.1. Stronger growth mindsets were associated with weaker fixed mindsets (r = -.74). Stronger fixed mindsets were negatively associated with effort attributions (r = -.28). Stronger growth mindsets were positively

associated with effort attributions (r = .25). Effort attributions made at mid-quarter were positively associated with effort attributions made at the end of the quarter (r = .42). Ability attributions at mid-quarter were positively associated with ability attributions made at the end of the quarter (r = .59). Neither growth mindsets nor fixed mindsets were associated with ability attributions. None of the mindset variables or attribution variables were associated with how well students perceived they performed on their midterm or final exam, end of quarter GPA, and gender.

Checking for Normality

A visual inspection of histograms, normal Q-Q plots, and box plots (Cramer, 1998; Cramer & Howitt, 2004; Doanne & Seward, 2011) showed that course-specific fixed mindset items were all skewed downward in Wave 2. Course-specific growth mindset items were all skewed upward in Wave 2. A visual inspection of plots indicated that the three effort attributions were all skewed upward in Wave 2 and Wave 3. All three ability attributions were normally distributed at both time points. Table 2.2 and Table 2.3 present the skewness and kurtosis of each item in Wave 2 and Wave 3, respectively. Mahalanobis distance analysis, which picks up on any cases that have a strange pattern of scores across the constructs, was used to find outliers. Mahalanobis distance is the distance of a particular case from the centroid of the remaining cases, where the centroid is the point created by the means of all the variables (Tabachnick & Fidell, 2007). Analysis revealed there were five multivariate outliers for the mindset items and two outliers for the attribution items in Wave 2. There were no outliers for attribution items in Wave 3. Outliers were not removed at this point to conserve the size of the sample and because the data was not skewed to a degree that would warrant concern.

Confirmatory Factor Analysis (CFA)

I conducted two separate confirmatory factor analyses to verify the factor structure of the mindset and attribution scales at Wave 2 and Wave 3 using structural equation modeling software in Stata 22 and relying on several statistical tests to determine the adequacy of the model fit to the data (e.g., chi-square test, comparative fit index, and RMSEA). Given that the course-specific mindset scale and the attribution scales are adaptations of well-established scales, it was necessary to test the hypothesis that the underlying latent constructs of a growth mindset, fixed mindset, effort attributions, and ability attributions exist for the adapted scales as well. Model 1 measured growth mindset, fixed mindsets, effort attributions, and ability attributions at Wave 2. Model 2 measured Wave 2 growth mindset, Wave 2 fixed mindset, Wave 3 effort attributions, and Wave 3 ability attributions. I hypothesized the two four-factor models to be confirmed in the measurement portion of the model after evaluating the assumptions of univariate and multivariate normality and linearity through SPSS 13. Less than one percent of data was missing on three attribution items and no one was missing data for the mindset variables; thus, maximum likelihood with missing values was used for the estimation and all 135 participants were included in both models. Model 1 measured four factors in Wave 2: growth mindset, fixed mindset, effort attributions, and ability attributions. Model 2 measured four factors: Wave 2 growth mindset and fixed mindset and Wave 3 effort attributions and ability attributions. For Model 1, χ^2 (48, n = 135) = 81.76, p = .002, the comparative fit index (CFI) = .97, the Tucker-Lewis fit index (TLI) = .96, and the RMSEA = .07. The four-factor model was an improvement from the baseline model, which only included two factors (i.e., all mindset indicators were included in one latent variable and all attribution indicators were included in a second latent variable), χ^2 (53, n = 135) = 308.30, p < .001, CFI = .74, TLI = .68, and RMSEA =

.19. For Model 2, χ^2 (48, n = 135) = 76.47, p = .01, CFI = .97, TLI = .96, and the RMSEA = .07. The four-factor model was an improvement from the two-factor baseline model, χ^2 (53, n = 135) = 205.86, p < .001, CFI = .83, TLI = .79, and RMSEA = .15. Goodness of fit indicators for both final models indicate a good fit between the model and the observed data compared with the baseline models. Standardized and unstandardized parameter estimates for each model are provided in Table 2.4.

Relationship Between Mindsets, Attributions, and Perceptions of Exam Performance

A series of preliminary analyses were performed to understand the existing relationships between mindsets, attributions, and students' perceptions of performance on their midterm and final exam. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, and multicollinearity, with no serious violations noted. In order to understand if students with different levels of performance perceptions differed in their mindsets and attributions, one-way multivariate analysis of covariance was performed to investigate the differences in students' mid-quarter growth mindset and fixed mindset and effort and ability attributions between students who reported they felt they did poor, fair, or well on their exams (See Table 2.5 for summary). The first model measured the impact of student's performance perceptions on their midterm and the second model measured the impact of students' performance perceptions on their final exam. Six dependent variables were used: growth mindset beliefs, fixed mindset beliefs, mid quarter effort and ability attributions, and end of quarter effort and ability attributions. The independent variable was students' perceptions of their performance on their exams. Covariates included class level. In both models, there was no statistically significant difference between the groups of how well students felt they performed on their midterm exam on the combined dependent variables, Midterm Model: F (12, 254) =

1.04, p = .42; Wilks' Lambda = .91; partial eta squared = .05; Final Exam Model: F (12, 254) = 1.02, p = .44; Wilks' Lambda = .91; partial eta squared = .05. There was no statistically significant difference between freshman and sophomores on the combined dependent variables, Midterm Model: F (6, 126) = 1.79, p = .11; Wilks' Lambda = .92; partial eta squared = .08; Final Exam Model: F (6, 126) = 1.70, p = .13; Wilks' Lambda = .93; partial eta squared = .08. When the results for the dependent variables were considered separately, none of them reached statistical significance. Overall, students' perceptions of how well they did on their midterm and final exam did not have an association with the attributions they made about their performance or students' mindset beliefs. Thus, separate group analyses were not conducted for subsequent analysis.

Repeated measures multivariate analysis of covariance (MANCOVA) was performed to investigate within-subject differences in students' effort and ability attributions at mid-quarter and post-quarter between freshman and sophomores (See Table 2.6 for summary). Two dependent variables were used: effort attributions and ability attributions. The independent variable was time. Covariates included class level. There was no statistically significant difference between the two time points on the combined dependent variables, F (2,132) = .16, p = .85; Wilks' Lambda = 1; partial eta squared = .002. There was no statistically significant difference between freshman and sophomores on the combined dependent variables, F (2,132) = .08, p = .93; Wilks' Lambda = 1; partial eta squared = .001. When the results for the dependent variables were considered separately (see Table X for summary), the only difference to reach statistical significance was an interaction between time and class level for ability attributions, F (1, 133) = 4.37, p = .04; partial eta squared = .03. An inspection of the mean scores indicated that overall, freshman had slightly stronger ability attributions by the end of the quarter (Time 1: M =

2.97, *SE* = .14; Time 2: *M* = 3.17, *SE* = .13), and sophomores had slightly weaker ability attributions by the end of the quarter (Time 1: *M* = 3.18, *SE* = .10; Time 2: *M* = 3.07, *SE* = .09); however, these mean changes indicate very little overall change in ability attributions. Overall, effort and ability attributions remained stable from mid-quarter to the end of quarter, indicating that students attributed their performance on their midterm and final exam to the same types of attributions.

Effect of mindsets on effort attributions. Model 1 (see Table 2.7) assessed the impact of mid-quarter growth mindset beliefs and students' performance perceptions on their midterm exam on mid-quarter effort attributions, controlling for gender, college generation status, and class level. The model included an interaction between mindset and exam perception. Gender, college-generation status, and class level were entered at Step 1 of the model, explaining 1% of the variance in effort attributions. After entry of growth mindset beliefs and perception of midterm exam performance at Step 2, the total variance explained by the model as a whole was 7.4%, *F* (6, 126) = 1.68, p = .13. The growth mindset and performance perception measure explained an additional 6.7% of the variance in effort attributions, after controlling for demographic characteristics, R squared change = .067, *F* change (3, 126) = 3.05, p = .03. In the final model, none of the independent measures reached statistical significance.

Model 2 (see Table 2.8) assessed the impact of mid-quarter fixed mindset beliefs and students' performance perceptions on their midterm exam on mid-quarter effort attributions, controlling for gender, college generation status, and class level. The model included an interaction between mindset and exam perception. Gender, college-generation status, and class level were entered at Step 1 of the model, explaining 1% of the variance in effort attributions. After entry of fixed mindset beliefs and perception of midterm exam performance at Step 2, the

total variance explained by the model as a whole was 9.6%, *F* (6, 126) = 2.24, p = .04. The fixed mindset and performance perception measure explained an additional 8.9% of the variance in effort attributions, after controlling for demographic characteristics, R squared change = .09, *F* change (3, 126) = 4.16, p = .01. Although the final model was statistically significant, none of the independent measures reached statistical significance.

Effect of mindsets on ability attributions. Model 3 (see Table 2.9) evaluated the impact of mid-quarter growth mindset beliefs on mid-quarter ability attributions and students' performance perceptions on their midterm exam, controlling for gender, college generation status, and class level. The model included an interaction between mindset and exam perception. Gender, college-generation status, and class level were entered at Step 1 of the model, explaining 1.2% of the variance in effort attributions. After entry of growth mindset beliefs and perception of midterm exam performance at Step 2, the total variance explained by the model as a whole was 1.2%, *F* (6, 126) = .26, p = .96. The growth mindset and performance perception measure explained no additional variance in ability attributions, after controlling for demographic characteristics, R squared change = 0, *F* change (3, 126) = .2, p = 1. In the final model, none of the independent measures reached statistical significance.

Model 4 (see Table 2.10) assessed the impact of mid-quarter fixed mindset beliefs and students' performance perceptions on their midterm exam on mid-quarter ability attributions, controlling for gender, college generation status, and class level. The model included an interaction between mindset and exam perception. Gender, college-generation status, and class level were entered at Step 1 of the model, explaining 1% of the variance in effort attributions. After entry of fixed mindset beliefs and perception of midterm exam performance at Step 2, the total variance explained by the model as a whole was 1.3%, *F* (6, 126) = .27, p = .95. The fixed

mindset and performance perception measure explained no additional variance in ability attributions, after controlling for demographic characteristics, R squared change = 0, *F* change (3, 126) = .05, p = .99. In the final model, none of the independent measures reached statistical significance.

Effect of mindsets on effort attributions over time. Model 5 (see Table 2.11) assessed the impact of mid-quarter growth mindset beliefs and students' perceptions of their performance on their final exam on end-of-quarter effort attributions, controlling for mid-quarter effort attributions, gender, college generation status, and class level. The model included an interaction between mindset and exam perception. Gender, college-generation status, and class level were entered at Step 1 of the model, explaining 1.2% of the variance in effort attributions. After entry of students' growth mindset beliefs and perception of final exam performance at Step 2, the total variance explained by the model was 20.3%, *F* (7, 125) = 4.54, p = < .001. The growth mindset and exam performance perception measures explained an additional 19.1% of the variance in end-of-quarter effort attributions, after controlling for gender, college-generation status, and class level, R squared change = .19, *F* change (4, 125) = 7.47, p = < .001. In the final model, only mid-quarter effort attributions were statistically significant with a beta value of .42 (p < .001). Overall, this model indicates that when the prior attribution is statistically controlled, growth mindset beliefs and final exam performance perception do not have an impact on effort attributions at the end of the quarter.

Model 6 (see Table 2.12) assessed the impact of mid-quarter fixed mindset beliefs and students' perceptions of their performance on their final exam on end-of-quarter effort attributions, controlling for mid-quarter effort attributions, gender, college generation status, and class level. The model included an interaction between mindset and exam perception. Gender,

college-generation status, and class level were entered at Step 1 of the model, explaining 1.2% of the variance in effort attributions. After entry of students' fixed mindset beliefs and perception of final exam performance at Step 2, the total variance explained by the model was 20%, *F* (7, 125) = 4.45, p = < .001. The fixed mindset and exam performance perception measures explained an additional 18.8% of the variance in end-of-quarter effort attributions, after controlling for gender, college-generation status, and class level, R squared change = .19, *F* change (4, 125) = 7.33, p = < .001. In the final model, only mid-quarter effort attributions were statistically significant with a beta value of .43 (p < .001). Overall, this model indicates that when the prior attribution is statistically controlled, fixed mindset beliefs and final exam performance perception do not have an impact on effort attributions at the end of the quarter.

Model 7 (see Table 2.13) evaluated the impact of mid-quarter growth mindset beliefs, mid-quarter ability attributions, and students' final exam perceptions on end-of-quarter ability attributions, controlling for gender, college generation status, and class level. The model included an interaction between mindset and exam perception. Gender, college-generation status, and class level were entered at Step 1 of the model, explaining 1.4% of the variance in end-of-quarter ability attributions. After entry of students' growth mindset beliefs and perception of final exam performance at Step 2, the total variance explained by the model was 38.4%, *F* (7, 125) = 11.12, p = < .001. The growth mindset and exam performance perception measures explained an additional 37% of the variance in end-of-quarter ability attributions, after controlling for gender, college-generation status, and class level, R squared change = .37, *F* change (4, 125) = 18.77, p = < .001. In the final model, only mid-quarter ability attributions were statistically significant with a beta value of .60 (p < .001). Overall, this model indicates that

when the prior ability attribution is statistically controlled, growth mindset beliefs and final exam performance perception do not have an impact on ability attributions at the end of the quarter. Model 8 (see Table 2.14) evaluated the impact of mid-quarter fixed mindset beliefs, mid-quarter ability attributions, and students' final exam perceptions on end-of-quarter ability attributions, controlling for gender, college generation status, and class level. The model included an interaction between mindset and exam perception. Gender, college-generation status, and class level were entered at Step 1 of the model, explaining 1.4% of the variance in ability attributions. After entry of students' fixed mindset beliefs and perception of final exam performance at Step 2, the total variance explained by the model was 38%, F (7, 125) = 10.96, p = < .001. The fixed mindset and exam performance perception measures explained an additional 36.7% of the variance in end-of-quarter ability attributions, after controlling for gender, college-generation status, and class level, R squared change = .37, F change (4, 125) = 18.50, p = < .001. In the final model, only mid-quarter ability attributions were statistically significant with a beta value of .60 (p < .001). Overall, this model indicates that when the prior ability attribution is statistically controlled, fixed mindset beliefs and final exam performance perception do not have an impact on ability attributions at the end of the quarter.

Discussion

Theories or intelligence, or mindsets, have typically been thought of as important components of student learning; however, several null findings in recent research has called into question the efficacy of mindset interventions and whether mindset beliefs have any real impact on student learning. Because the mindsets typically measured in previous studies are global and general beliefs of intelligence, I argued perhaps personal and domain-specific measure of mindset may be more closely related to students' academic beliefs and performance. Moreover,

beliefs about the malleability of their intelligence may not always be something that students are always actively considering compared to other types of beliefs, such as effort and ability attributions, that students may readily think about when thinking about their academic performance outcomes. For example, when faced with a less than desirable grade on an exam, a student may think, "I could have done better if I had studied more," attributing their poor performance to lack of effort. These types of effort attributions may stem from their growth mindset which leads them to believe their general intelligence has the potential to grow with increased efforts (Dweck, 2000); Weiner, 1972), but students' situation-specific attributions may be more closely related to their course-specific mindsets, especially when these attributions are as a result of real-life academic experiences. Thus, students' course-specific mindsets may inform and direct the specific behaviors that students choose to partake in while preparing for their exams. For instance, if a student believes their knowledge and intelligence are likely to grow in a given course, they may be more likely to spend more time studying and seeking help from professors and peers.

The present study aimed to explore the relationship between students' effort and ability attributions with their growth and fixed mindset beliefs in challenging course context. The first research question aimed to explore whether effort attributions change over the course of a quarter, from the time students take their midterm exams to their final exams. We found no evidence of effort attributions changing over the course of the quarter, indicating that students use the same type of effort attributions to understand their performance. The second research question explored whether having a growth mindset related to making stronger effort attributions; however, we did not find evidence that indicated having a growth mindset would result in stronger endorsement of effort attributions. The third research question explored

whether ability attributions changed over the course of an academic quarter. It appeared that ability attributions did not change and that students used the same type of ability information to understand their performance. The fourth research question investigated whether having a fixed mindset was associated with making stronger ability attributions; however, there was no evidence indicating that having a fixed mindset was related to a stronger endorsement of ability attributions. Although no statistically significant relationships were found between mindsets and attributions, it appeared that both growth mindsets and fixed mindsets were less likely to be associated with ability attributions compared to effort attributions. This study also considered whether students' perceptions of their performance on their exams interacted with the types of mindset beliefs and attributions they endorsed, finding that students who felt they did well on their exams did not have different mindsets or make different types of performance attributions compared to students who felt they performed fairly or poorly on their exams. Overall, none of the hypothesized relationships were confirmed.

The lack of statistically significant relationships between mindsets and attributions is surprising, when considering findings from past research (Hong et al., 1999; Robins & Pals, 2002), but perhaps provides additional insight to the recent null relationships found between mindsets and student achievement. I suggested that attributions may serve as a psychological mediator between students' mindsets and their achievement, providing an avenue through which students mindsets may be enacted in real-life academic settings, but given that the results of this study do not indicate a relationship between mindsets and attributions, there was no support for this claim. One criticism of mindset theory suggests that beliefs about the malleability of intelligence are abstract concepts that are too far removed from students' academic settings. However, the adapted personalized course-specific mindset used in the present study did not

indicate a closer relationship to students' other academic beliefs. Thus, one explanation might be that students' beliefs about their intelligence, even course-specific intelligence, does not directly influence the types of attributions students make about their performance. For example, even though a student endorses the belief that their intelligence in biology has the potential to grow over time, they were not more or less likely to attribute their performance on their exams to studying more or devoting more time to practicing the material. Bahnik and Vranka (2017) found that students who had a growth mindset were not more likely to take additional administrations of a scholastic aptitude test for the chance to improve upon their scores, further highlighting that global beliefs regarding the malleability of intelligence may not be as closely related to students' learning behaviors.

Although students' growth mindsets and effort attributions were moderately correlated, students' ability attributions had no correlation or relationship with either type of mindset belief, indicating that whether a student attributes their performance to their natural ability, intelligence, or talent has very little to do with whether they believe their intelligence is malleable. The lack of relationship here is notable, indicating that the way students think about their intelligence as a fixed or malleable construct does not relate to the way they understand their intelligence or talent as a cause of their performance in school. Another possible explanation for the lack of relationship could be that as a whole, the sample used in the present study may be more effort-oriented, with most students endorsing growth mindsets and moderate to strong effort attributions. I suggested that intelligence beliefs may be one type of belief system that is related to other more salient belief systems that students face every day in the classroom or in their interactions with course material. Students may not spend a considerable amount of time thinking about whether or not they can alter their intelligence compared to how often they think

about how much they need to study in order to learn the requisite material. However, much like recent studies that have failed to replicate a relationship between mindset constructs and student achievement (Bahnik & Vranka, 2017; Education Endowment Foundation, 2018; Sisk et al., 2018), the results of the present study indicate that theories of intelligence are not closely to related to expected performance beliefs either, begging the question of what mindsets actually do impact.

I hypothesized that in a challenging course context, attributions might change from the midpoint of the quarter to the end of the quarter, because we might expect that students' performance expectations would be less likely to be met in their most challenging courses, leading to an adjustment in their effort and ability attributions. For instance, students who attributed their performance on their midterm to their lack of ability or intelligence in a given course may be more likely to endorse effort attributions for their final exam if their poor performance on their midterm exam led them to put in more time and effort to increase their course grades. It is important to note that there were only 4-5 weeks between the time students took their midterm and final exam, which may be too short of a time frame to see any real change in the attributions that students make for their performance. Students may continue to engage in the same academic behaviors for several academic quarters, especially if these behaviors are working in their favor. Further research may explore if attributions differ over longer periods of time. Nonetheless, students' attributions were not related to their perceptions of how well they performed on their exams. This may be due to the fact that 76% of students felt they performed fair or well on their midterm exams and 84% felt they performed fair or well on their final exam, indicating that most students were content with their performance. Perhaps if the sample had more students who felt they performed poorly on their exams, we might have

seen more variability in the types of attributions endorsed or even noticed a change in the types of attributions students endorsed by the end of the quarter. Because most students felt they did fair to well on their exams, we would expect they would not necessarily adjust their study habits for the final exam, if they believed what they had done for their midterm had worked in their favor. The majority of the students in the sample were either from social science/social ecology majors or undeclared and selected humanities, non-major biological science, or social science courses as their most difficult course. Student perceptions of their performance may be more closely related to student attributions in different types of majors or classes.

Future Directions and Concluding Remarks

Millions of dollars have been devoted to the funding of mindset interventions and many schools have since implemented mindset training into their curriculum, hoping for a panacea to struggling and demotivated students. Few would disagree with the attractive idea that individuals should believe in the fact that their intelligence is a changeable construct with the potential to develop and increase over time with more effort and persistence. However, most people already seem to have a growth mindset to some extent, so are the interventions even necessary? It makes little sense to intervene to change a belief that individuals already seem to agree without an intervention. In the present study's sample, which albeit small, was representative of bigger population from which it was drawn (although probably not representative of all undergraduate students or people in the United States), most students endorsed a growth mindset much more than a fixed mindset, with very few students endorsing fixed mindsets more than a growth mindset. The generation of undergraduates in my sample did not grow up in schools that paid for mindset "brain training" to be implemented into their classrooms, and yet most of them already agree that their intelligence can change, begging the question of how students acquired these

beliefs in the first place. It is possible that teachers and parents have been already nurturing beliefs about improvement and effort-focused learning all along. Further qualitative exploration into what a growth mindset and fixed mindset means to students is needed, including an understanding how these beliefs were influenced and nurtured. Future research might look at younger and older samples that are more gender-balanced.

Furthermore, it is possible that too much importance is being placed on intelligence theories, when the evidence of its impacts on learning is wavering. Several recent studies have failed to find evidence that global beliefs about intelligence have any impact on students' actual performance and the present study failed to find any impact of course-specific mindsets on course-specific academic attributions. The present study failed to find a relationship between students' mindsets and the factors they use to determine their performance, finding that regardless of their mindset, most students were likely to moderately endorse effort-oriented explanations for their performance. Future work might look at whether students' attributions for their performance might be a better predictor of achievement than their mindsets, further delving into the relationship between learning outcomes, mindsets, and attributions. In the face of replication issues across the globe, more evidence that mindsets do in fact impact student outcomes and student motivation is needed before more schools begin to incorporate mindset trainings into their core curriculum.

References

Ablard, K. E. (2002). Achievement goals and implicit theories of intelligence among academically talented students. *Journal for the Education of the Gifted, 25*(3), 215–232. doi:10.1177/016235320202500302

Bahník, S., Vranka M.S. (2017). Growth mindset is not associated with scholastic aptitude in a large sample of university applicants. *Personality and Individual Differences, 117*, 139–143

Blackwell, K. L., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*(1), 246–263. doi:10.1111/j.1467-8624.2007.00995.x

Cramer, D. (1998). *Fundamental statistics for social research.* London: Routledge.

Cramer, D., & Howitt, D. (2004). *The SAGE dictionary of statistics.* London: SAGE.

De Castella, K., & Byrne, D. (2015). My intelligence may be more malleable than yours: The revised implicit theories of intelligence (self-theory) scale is a better predictor of achievement, motivation, and student disengagement. *European Journal of Psychology of Education*, *30*(3), 245–267.

Diener, C. I., & Dweck, C. S. (1980). An analysis of learned helplessness: II. The processing of success. *Journal of Personality and Social Psychology, 39*(5), 940-952. doi:10.1037/0022-3514.39.5.940

Doanne, D.P., & Seward, L.E. (2011). Measuring Skewness. *Journal of Statistics Education, 19*(2), 1-18.

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. New York, NY: Psychology Press.

Dweck, C. S. (2007). *Mindset: The new psychology of success*. New York, NY: Ballantine Books.

Dweck, C. S. (2015). Growth mindset, revisited. *Education Week.* Retrieved from http://www.edweek.org/ew/articles/2015/09/23/carol-dweck-revisits-the-growth-mindset.html

Dweck, C. S., Chiu, C. & Hong, Y. (1995a). Implicit theories and their role in judgments and reactions: A world from two perspectives. *Psychological Inquiry, 6,* 267-285. doi: 10.1207/s15327965pli0604_12

Dweck, C. S., & Leggett, E. L. (1988). A social cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256–273. doi:10.1037/0033-295X.95.2.256

Dweck, C. S., & Molden, D. C. (2017). Mindsets: Their impact on competence motivation and acquisition. In A.J. Elliot, C.S. Dweck, & D.S. Yeager (Eds,), *Handbook of competence and motivation, Second Edition, Theory and Application* (135-154). New York, NY: Guilford Publications.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., et al. (1983). Expectancies, values and academic behaviors. In J. T. Spencer (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 75-146). San Francisco: W. H. Freeman.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53,* 109-132.

Education Endowment Foundation. (2018). Changing mindsets. What Works Centre for Education.

Elig, T. W., & Frieze, I. H. (1979). Measuring causal attributions for success and failure. *Journal*

of Personality and Social Psychology, *37*, 621-634.

Henderson, V. L., & Dweck, C. S. (1990). Achievement and motivation in adolescence: A new model and data. In S. Feldman & G. Elliott (Eds.) *At the threshold: The developing adolescent*. Cambridge, MA: Harvard University Press.

Hendrick, C. (2019). The growth mindset problem. *AEON*.

Hong, Y., Chiu, C., Dweck, C. S., Lin, D. M., & Wan, W. (1999). Implicit theories, attributions, and coping: A meaning system approach. *Journal of Personality and Social Psychology*, *77*(3), 588-599. doi:10.1037/0022- 3514.77.3.588

Leondari, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived competence: Impact on students' achievement behavior. *Psychology in the Schools*, *39*(3), 279–291. doi:10.1002/pits.10035

MacGyvers, V. (1992). Implicit theories and real-world outcomes. Unpublished doctoral thesis, University of Illinois at Urbana-Champaign.

Mueller, C.M., & Dweck, C.S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology, 75*, 33–52.

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015). Mind-set interventions are a scalable treatment for academic underachievement. Psychological Science, 26, 784–793. http://dx.doi.org/10.1177/0956797615571017

Plaks, J. E., & Stecher, K. (2007). Unexpected improvement, decline, and stasis: A prediction confidence perspective on achievement success and failure. *Journal of Personality and Social Psychology, 93*(4), 667–684.

Robins, R. W., & Pals, J. L. (2002). Implicit self-theories in the academic domain: Implications for goal orientation, attributions, affect, and self-esteem change. *Self and Identity, 1*(4),

313–336.

Romero, C., & Master, A. (2014). Academic and emotional functioning in middle school: The role of implicit theories. *Emotion*, *14*(2), 227-234. doi: 10.1037/a0035490

Schulz, R., & Heckhausen, J. (1999). Aging, culture, and control: Setting a new research agenda. *Journal of Gerontology: Psychological Sciences*, *54B*(3), 139-145.

Sisk, V.F., Burgoyne, A.P., Sun, J., Butler, J.L., Macnamara, B.N. (2018). To what extent and under which circumstances are growth mindsets important to academic achievement? Two meta-analyses. *Psychological Science*, *29*(4), 549-571.

Stipek, D., & Gralinski, J. H. (1996). Children's beliefs about intelligence and school performance. *Journal of Educational Psychology*, 88, 397- 407. doi:10.1037/0022-0663.88.3.397

Tabachnick, B.G., & Fidell, L.S. (2007). *Using multivariate statistics*. New York, NY: Pearson.

Weiner, B. (1972). Achievement attribution and the educational process. *Review of Educational Research*, *42*(2), 203–215. doi:10.2307/1170017

Weiner, B. (1974). *Achievement motivation and attribution theory.* Morristown, N.J.: General Learning Press.

Weiner, B. (1986). *An attributional theory of motivation and emotion*. New York: Springer-Verlag.

Weiner, B., & Kukla, A. (1970). An attributional analysis of achievement motivation. *Journal of Personality and Social Psychology*, 15, 1-20. doi: 10.1037/h0029211

Wigfield, A., & Eccles, J. S. (2002). Children's motivation during the middle school years. In J. Aronson (Ed.), *Improving academic achievement: Contributions of social psychology*. San Diego, CA: Academic Press.

Yeager, D.S. & Dweck, C.S. (2012) Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist, 47*(4), 302-314, DOI: 10.1080/00461520.2012.722805

Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., . . . Dweck, C. S. (2016). Using design thinking to improve psychological interventions: The case of the growth mindset during the transition to high school. Journal of Educational Psychology, 108, 374-391. doi:10.1037/edu0000098

Table 2.1

Descriptive Statistics and Correlations

	M/ %	SD	1	2	3	4	5	6	7	8	9	10
1 Wave 2: Course-specific Fixed Mindset in hardest course	2.81	1.13	--	-.74***	-.28**	-.01	-.17	.09	-.17	-.07	-.02	.02
2 Wave 2: Course-specific Growth Mindset in hardest course	4.64	1.05		--	.25**	.02	.16	-.10	-.06	-.06	-.02	0
3 Wave 2: Effort attributions	4.08	.78			--	.08	.42***	.15	-.01	-.16	.06	-.03
4 Wave 2: Ability attributions	3.11	.95				--	-.04	.59***	.01	-.08	.02	.01
5 Wave 3: Effort attributions	4.08	.76					--	.14	.05	.02	.13	.11
6 Wave 3: Ability attributions	3.10	.86						--	-.12	-.11	-.06	.10
7 Wave 2: Perceptions of Performance on Midterm	2.21	.80							--	.39***	.38***	.13
8 Wave 3: Perceptions of Performance on Final Exam	2.32	.74								--	.33***	-.03
9 End of quarter GPA	3.17	.65									--	-.04
10 Gender: Female	76%	--										--

Note. *p < .05, **p < .01, *** p < .001

Table 2.2

Wave 2 Item Analysis of Normality

	Skewness (SE)	Kurtosis (SE)
Most Difficult Course		
Course-specific Fixed Mindset		
Item 1	.82 (.21)	.42 (.41)
Item 2	.72 (.21)	.11 (.41)
Item 3	.57 (.21)	-.40 (.41)
Course-specific Growth Mindset		
Item 1	-1.12 (.21)	1.72 (.41)
Item 2	-1.09 (.21)	1.61 (.41)
Item 3	-1.23 (.21)	1.73 (.41)
Effort Attributions		
Item 1	-.97 (.21)	.72 (.42)
Item 2	-.91 (.21)	.36 (.42)
Item 3	-.73 (.21)	-.36 (.42)
Ability Attributions		
Item 1	-.06 (.21)	-.71 (.42)
Item 2	.10 (.21)	-.82 (.42)
Item 3	-.14 (.21)	-.82 (.42)

Table 2.3

Wave 3 Item Analysis of Normality

	Skewness (SE)	Kurtosis (SE)
Effort Attributions		
Item 1	-.89 (.21)	.07 (.42)
Item 2	-.62 (.21)	-.52 (.42)
Item 3	-.60 (.21)	-.63 (.42)
Ability Attributions		
Item 1	.02 (.21)	-.47 (.42)
Item 2	.11 (.21)	-.52 (.42)
Item 3	-.10 (.21)	-.69 (.42)

Table 2.4

Confirmatory Factor Analysis of Mindset and Attribution Scales: Standardized and Unstandardized Coefficients

Observed	Latent construct	β	*SE*	*B*	*SE*
Model 1: Wave 2 Mindsets and Wave 2 Attributions					
Item 1	Fixed mindset	.86	.03	1	--
Item 2	Fixed mindset	.93	.02	1.07	.08
Item 3	Fixed mindset	.83	.03	1.07	.09
Item 1	Growth mindset	.89	.02	1	--
Item 2	Growth mindset	.94	.01	1.04	.06
Item 3	Growth mindset	.95	.01	1.11	.06
Item 1	W2 Effort attributions	.85	.05	1	--
Item 2	W2 Effort attributions	.77	.05	1.01	.13
Item 3	W2 Effort attributions	.64	.06	.78	.12
Item 1	W2 Ability attributions	.67	.06	1	--
Item 2	W2 Ability attributions	.83	.05	1.24	.18
Item 3	W2 Ability attributions	.78	.05	1.05	.15
Model 2: Wave 2 Mindsets and Wave 3 Attributions					
Item 1	Fixed mindset	.86	.03	1	--
Item 2	Fixed mindset	.93	.02	1.07	.08
Item 3	Fixed mindset	.83	.03	1.07	.09
Item 1	Growth mindset	.89	.02	1	--
Item 2	Growth mindset	.94	.01	1.04	.06
Item 3	Growth mindset	.95	.01	1.11	.06
Item 1	W3 Effort attributions	.71	.06	1	--
Item 2	W3 Effort attributions	.89	.06	1.01	.13
Item 3	W3 Effort attributions	.61	.07	.78	.12
Item 1	W3 Ability attributions	.61	.08	1	--
Item 2	W3 Ability attributions	.58	.08	1.24	.18
Item 3	W3 Ability attributions	.91	.09	1.05	.15

Table 2.5

Summary of Multivariate Analyses of Covariance (MANCOVA): Students' Exam Performance Perceptions, Mindset Beliefs, and Effort and Ability Attributions

Effects of the DVs	*SS*	*MS*	*df*	*F*
Model 1: Midterm Perceptions				
Combined Effects				
Perceptions of Midterm Performance Group	--	--	12	1.79
Class Level	--	--	6	1.04
Separate Effects				
Growth Mindset	1.28	0.64	2	0.6
Fixed Mindset	5.16	2.58	2	2.12
Mid-Quarter Effort Attributions	0.01	0.01	2	0.01
Mid-Quarter Ability Attributions	0.14	0.07	2	0.08
End-Quarter Effort Attributions	1.23	0.62	2	1.05
End-Quarter Ability Attributions	2.04	1.02	2	1.37
Model 2: Final Exam Perceptions				
Combined Effects				
Perceptions of Final Exam Performance	--	--	12	1.02
Class Level	--	--	6	1.7
Separate Effects				
Growth Mindset	0.45	0.22	2	0.21
Fixed Mindset	1.34	0.67	2	0.54
Mid-Quarter Effort Attributions	2.62	1.31	2	2.17
Mid-Quarter Ability Attributions	0.86	0.43	2	0.48
End-Quarter Effort Attributions	0.17	0.09	2	0.14
End-Quarter Ability Attributions	1.18	0.59	2	0.79

Note. Student's perceptions of their performance on their midterm and final exam are the independent variable in each model. Students belonged to one of three perception groups: poor, fair, or well. Covariates included class level (freshman or sophomore). A dashed line indicates the measure was not included for the analysis. *SS* = sum of squares. *MS* = mean square. * $p < .05$

Table 2.6

Summary of Repeated Measures Multivariate Analyses of Covariance (MANCOVA): Effort and Ability Attributions of Freshman and Sophomores at the Beginning and End of Quarter

Effects of the DVs	*SS*	*MS*	*df*	*F*
Combined Effects				
Time	--	--	2	.16
Class Level	--	--	2	.08
Time*Class Level	--	--	2	2.21
Separate Effects				
Effort Attributions				
Time	.001	.001	1	.001
Time*Class Level	.001	.001	1	.001
Error	46.07	.35	133	--
Ability Attributions				
Time	.11	.11	1	.33
Time*Class Level	1.44	1.44	1	4.37
Error	43.94	.33	133	--

Note. Time is the independent variable. Each dependent variable is measured at two time points, at the middle of the quarter and at the end of the quarter. Covariates included class level: freshman or sophomore. A dashed line indicates the measure was not included for the analysis. *SS* = sum of squares. *MS* = mean square. * $p < .05$

Table 2.7

Model 1: Results of Hierarchical Regression Analysis for Growth Mindset, Midterm Performance Perceptions, and Mid-Quarter Effort Attributions

Independent Variables	β	t	*p*	R^2	Delta R^2	*F* change	Sig. *F*
Step 1: Demographic Variables				.01	.01	.30	.82
Gender	-.03	-.36	.72				
College-generation status	.08	.90	.37				
Class Level	-.01	-.08	.94				
Step 2: Mindset Variables				.07	.07	3.05	.03
Gender	-.04	-.44	.66				
College-generation status	.05	.57	.57				
Class Level	-.06	-.64	.52				
Growth Mindset	.06	.24	.81				
Midterm Performance Perception	-.34	-.92	.36				
Growth Mindset*Midterm Performance Perception	.39	.89	.37				

Note. Degrees of freedom for Step 1, *F* (3, 129); for Step 2, *F* (6, 126).

Table 2.8

Model 2: Results of Hierarchical Regression Analysis for Fixed Mindset, Midterm Performance Perceptions, and Mid-Quarter Effort Attributions

Independent Variables	β	t	*p*	R^2	Delta R^2	*F* change	Sig. *F*
Step 1: Demographic Variables				.01	.01	.30	.82
Gender	-.03	-.36	.72				
College-generation status	.08	.90	.37				
Class Level	-.01	-.08	.94				
Step 2: Mindset Variables				.10	.09	4.16	.01
Gender	-.03	-.29	.77				
College-generation status	.07	.79	.43				
Class Level	-.06	-.72	.47				
Fixed Mindset	-.04	-.17	.87				
Midterm Performance Perception	.20	.88	.38				
Fixed Mindset*Midterm Performance Perception	-.34	-1.20	.23				

Note. Degrees of freedom for Step 1, *F* (3, 129); for Step 2, *F* (6, 126).

Table 2.9

Model 3: Results of Hierarchical Regression Analysis for Growth Mindset, Midterm Performance Perceptions, and Mid-Quarter Ability Attributions

Independent Variables	β	t	*p*	R^2	Delta R^2	*F* change	Sig. *F*
Step 1: Demographic Variables				.01	.01	.51	.68
Gender	-.03	.29	.77				
College-generation status	-.01	-.06	.96				
Class Level	.11	1.22	.22				
Step 2: Mindset & Performance Perceptions				.01	0	.02	1
Gender	.03	.29	.77				
College-generation status	-.01	-.06	.95				
Class Level	.11	1.19	.24				
Growth Mindset	.04	.18	.86				
Midterm Performance Perception	.08	.21	.84				
Growth Mindset*Midterm Performance Perception	-.09	-.20	.84				

Note. Degrees of freedom for Step 1, *F* (3, 129); for Step 2, *F* (6, 126).

Table 2.10

Model 4: Results of Hierarchical Regression Analysis for Fixed Mindset and Mid-Quarter Ability Attributions with Midterm Performance Perceptions as a Covariate

Independent Variables	β	t	*p*	R^2	Delta R^2	*F* change	Sig. *F*
Step 1: Demographic Variables				.01	.01	.51	.68
Gender	-.03	.29	.77				
College-generation status	-.01	-.06	.96				
Class Level	.11	1.22	.22				
Step 2: Mindset & Performance Perceptions				.01	0	.05	.99
Gender	.02	.27	.79				
College-generation status	-.01	-.05	.96				
Class Level	.11	1.23	.22				
Fixed Mindset	-.05	-.21	.83				
Midterm Performance Perception	-.06	-.25	.81				
Fixed Mindset*Midterm Performance Perception	.09	.31	.76				

Note. Degrees of freedom for Step 1, *F* (3, 129); for Step 2, *F* (6, 126).

Table 2.11

Model 5: Results of Hierarchical Regression Analysis for Growth Mindset and Final Exam Performance Perceptions and End-Quarter Effort Attributions

Independent Variables	β	t	*p*	R^2	Delta R^2	*F* change	Sig. *F*
Step 1: Demographic Variables				.01	.01	.52	.67
Gender	-.11	-1.22	.23				
College-generation status	.03	.32	.75				
Class Level	-.01	-.07	.94				
Step 2: Mindset & Performance Perceptions				.20	.19	7.47	<.001
Gender	-.09	-1.13	.26				
College-generation status	-.01	-.16	.88				
Class Level	-.01	-.12	.91				
Growth Mindset	.23	.76	.45				
Mid-Quarter Effort Attributions	.42***	4.98	<.001				
Final Exam Performance Perception	.31	.79	.43				
Growth Mindset*Final Exam Performance Perception	-.27	-.57	.57				

Note. Degrees of freedom for Step 1, *F* (3, 129); for Step 2, *F* (7, 125). ***$p < .001$

Table 2.12

Model 6: Results of Hierarchical Regression Analysis for Fixed Mindset and Final Exam Performance Perceptions and End-Quarter Effort Attributions

Independent Variables	β	t	*p*	R^2	Delta R^2	*F* change	Sig. *F*
Step 1: Demographic Variables				.01	.01	.52	.67
Gender	-.11	-1.22	.23				
College-generation status	.03	.32	.75				
Class Level	-.01	-.07	.94				
Step 2: Mindset & Performance Perceptions				.20	.19	7.33	<.001
Gender	-.10	-1.17	.24				
College-generation status	0	-.05	.96				
Class Level	-.01	-.09	.93				
Fixed Mindset	-.15	-.56	.58				
Mid-Quarter Effort Attributions	.43***	4.99	<.001				
Final Exam Performance Perception	0	-.01	1				
Fixed Mindset*Final Exam Performance Perception	.14	.42	.68				

Note. Degrees of freedom for Step 1, *F* (3, 129); for Step 2, *F* (7, 125). ***$p < .001$

Table 2.13

Model 7: Results of Hierarchical Regression Analysis for Growth Mindset and Final Exam Performance Perceptions and End-Quarter Ability Attributions

Independent Variables	β	t	*p*	R^2	Delta R^2	*F* change	Sig. *F*
Step 1: Demographic Variables				.01	.01	.59	.62
Gender	.10	1.12	.26				
College-generation status	-.04	-.44	.66				
Class Level	-.04	-.41	.69				
Step 2: Mindset & Performance Perceptions				.38	.37	18.77	<.001
Gender	.09	1.19	.24				
College-generation status	-.03	-.37	.71				
Class Level	-.08	-1.13	.26				
Growth Mindset	.03	.10	.92				
Mid-Quarter Ability Attributions	.60***	8.42	<.001				
Final Exam Performance Perception	.09	.26	.79				
Growth Mindset*Final Exam Performance Perception	-.20	-.47	.64				

Note. Degrees of freedom for Step 1, *F* (3, 129); for Step 2, *F* (7, 125). ****p* < .001

Table 2.14

Model 8: Results of Hierarchical Regression Analysis for Fixed Mindset and Final Exam Performance Perceptions and End-Quarter Ability Attributions

Independent Variables	β	t	*p*	R^2	Delta R^2	*F* change	Sig. *F*
Step 1: Demographic Variables				.01	.01	.59	.62
Gender	.10	1.12	.26				
College-generation status	-.04	-.44	.66				
Class Level	-.04	-.41	.69				
Step 2: Mindset & Performance Perceptions				.38	.37	18.50	<.001
Gender	.09	1.20	.23				
College-generation status	-.04	-.50	.62				
Class Level	-.09	-1.24	.22				
Fixed Mindset	.17	.71	.48				
Mid-Quarter Ability Attributions	.60***	8.40	<.001				
Final Exam Performance Perception	.02	.12	.90				
Fixed Mindset*Final Exam Performance Perception	-.13	-.45	.66				

Note. Degrees of freedom for Step 1, *F* (3, 129); for Step 2, *F* (7, 125). ***$p < .001$

	Mid-Quarter (Wave 2)	Post-Quarter (Wave 3)
Hardest course growth mindset	✓	
Hardest course fixed mindset	✓	
Hardest course effort causal attributions for midterm/final exam	✓	✓
Hardest course ability attributions for midterm/final exam	✓	✓
Perceptions of performance on midterm/final exam in hardest course	✓	✓

Figure 2.1. Summary of Chapter 2 Measures

Chapter 3: A Pattern Centered Approach to Undergraduates' Mindsets and Performance Attributions: Rethinking the effort-championed motives of the growth mindset

Abstract

Mindset theory has advocated the idea that having a growth mindset and effort-oriented thinking is a primary determinant of academic success; however, in this study we take a pattern-centered approach to illustrate that perhaps believing in both effort and talent are the keys to academic success, engagement, and motivation. We suggest having a growth mindset may be more impactful for academic performance and motivation when students believe in the dual power of their efforts and abilities, rather than effort alone. Cluster analysis revealed four unique types of mindset and attribution belief patterns in 135 undergraduate students at a California university across two time points in an academic quarter. We assessed how these patterns were associated with academic performance indicators (course grades and GPA) and motivation-related beliefs (self-concept of ability and subjective task value). Results indicated that students who strongly endorsed a growth mindset as well as strong effort and ability attributions had stronger subjective task value (attainment value, utility value, and intrinsic value) and self-concept of ability for their hardest course compared with students who had stronger fixed mindset beliefs coupled with moderate effort and ability attributions and students who had more moderate growth and fixed mindset views coupled with lower effort and ability attributions. There were no statistically significant differences between the four types of patterns in regard to academic performance indicators.

Chapter 3: A Pattern Centered Approach to Undergraduates' Mindsets and Performance Attributions: Rethinking the effort-championed motives of the growth mindset

The present study aims to bridge together two seminal perspectives on how students understand the malleability of their intelligence and the causal explanations of their academic performance. In recent years, the popularity of implementing the growth mindset into schools and everyday thinking has soared. Many studies that assess students' mindsets prior to any interventions point out that the majority of students appear to endorse a growth mindset, suggesting that even without intervention, such effort-focused beliefs are popular and widespread among students. In particular, growth mindset interventions have been shown to benefit struggling students more than high performing students, suggesting that this particular way of thinking has different impacts on different types of students. Indeed, growth mindsets may be more impactful for some students depending on other types of beliefs they endorse about their intelligence or academic performance. I suggest one type of belief that may play an important role in the way mindsets impact achievement outcomes, motivation, and engagement is causal performance attributions. Past research has shown that specific attributions moderate the relationship between general mindsets and many achievement-related outcomes, and mindset theory suggests that students who have growth mindsets will have more effort-focused thinking, and endorse more effort-oriented causal performance attributions because their belief in the malleability of their intelligence will cause them to take more steps to improve their academic outcomes, which they will then see as the causes of their performance. Dweck and associates caution against having a fixed mindset, person-praise, and ability focused thinking; however, seminal perspectives such as attribution theory and expectancy value theory would suggest that attributing successful performance to stable factors like intelligence also lead to strong

motivation and engagement, if not more than if students were to attribute their performance to effort alone. The pitfalls of having a fixed mindset have been widely discussed, but beyond findings that suggest students with a fixed mindset make less effort attributions (Hong et al., 1999) the impact of students' ability causal attributions, effort causal attributions, and fixed mindsets beliefs on student academic performance and engagement has seldom been discussed. For example, it is unclear if students who have fixed mindset about their intelligence but make strong effort causal attributions might be somewhat protected against the debilitating impacts of believing their intelligence did not have the potential to grow.

In the present study, we explore the role of effort and ability attributions in conjunction with students' growth and fixed mindsets. Although mindset theory would champion the idea that effort is the primary determinant of success, we take an intra-individual approach to illustrate that believing in both effort and talent may be the key to academic success, engagement, and motivation. I argue that students who endorse a growth mindset and make effort attributions as well as ability attributions will experience the greatest psychological benefits of having a growth mindset because such students will feel more pride in their successful accomplishments and continue seeking ways to improve their performance because they have a strong belief in the power of their efforts to grow their intelligence in a given subject domain but also have confidence in their ability to succeed. We predict that such students will experience more benefits than students who endorse a growth mindset and only effort attributions because these latter students will believe that their successes are due mainly to their efforts, not to their innate/ stable talents, abilities, or intelligence. Students who only make effort attributions alongside their growth mindset may be less likely to believe they are truly talented in a domain, decreasing the likelihood of them pursuing further courses or a career in that field, and

may reduce the value they attach to a particular subject, especially when the effort expenditure becomes greater than they would like to put forth.

Literature Review

Dweck's Mindset Theory and Weiner's Attribution Theory

According to mindset theory, Dweck and her associates (Dweck, Chiu, & Hong, 1995a; Dweck & Leggett, 1988) argued that people's implicit theories about themselves guide them to engage in certain behaviors and influence the causal attributions they make about their academic successes and failures. More specifically, they proposed two types of implicit theories — incremental theory (a growth mindset) and entity theory (a fixed mindset). Having a growth mindset for intelligence means that an individual sees intelligence as something they can cultivate through effort and learning; thus, they would attribute their successes and failures alike to their effort and would be likely to persist in trying to master the challenging material as long as they value it (Dweck, 2000). Students with a growth mindset are more confident in their ability to change their future academic outcomes through studying or increased efforts compared to students with a fixed mindset; therefore, they are more likely to take measures to learn the information needed to do well (Mueller & Dweck, 1998; Plaks & Stecher, 2007). Having a fixed mindset for intelligence means that an individual sees their intelligence as reflecting a fixed amount of talent that is immutable, thus they attribute their negative academic outcomes to lack of talent, and they do not think they can do much to alter their fixed amount of intellectual aptitude (Dweck, 2000). Such a belief will lead to low expectations for future success, self-doubt, and giving up in the face of failure (Dweck, 2000; Plaks & Stecher, 2007; Weiner, 1986). Advocates of mindset theory argue that focusing on stable factors such as intelligence or talent as the causes of performance lead people to become highly concerned with measuring and

validating their intelligence, often to the detriment of learning. Students with a fixed mindset tend to excel as long as the information comes easily for them, but their achievement lessens when they are faced with academic challenges or setbacks (Mueller & Dweck, 1998).

In his causal attribution theory, Weiner (1972) argued that achievement related causal attributions influence whether students persist or give up after academic failures (Weiner, 1985; Weiner & Kukla, 1970). Weiner identified ability, effort, task difficulty, and luck as the most important factors that affect achievement attributions. Furthermore, attributions are classified along three causal dimensions: locus of control (internal versus external), stability (stable versus unstable), and controllability (uncontrollable versus controllable) (Weiner, 1974). In the current study, we focus on two factors—ability and effort. Students with higher achievement and greater confidence in their abilities tend to attribute their successes to internal, stable, and uncontrollable factors such as ability and attribute their failures to internal, unstable, controllable factors such as effort (Weiner, 1974). Attributing failures to unstable factors such as effort allows the person to believe they have volitional control and can increase or decrease their effort on future occasions. In a similar vein, Dweck and her associates (Dweck et al., 1995a; Dweck & Leggett, 1988) champion effort-focused thinking and process-oriented learning. They argue that people's implicit theories about themselves guide them to engage in certain behaviors and cause them to make certain causal attributions about their academic successes and failures.

Differential Achievement and Motivation Impacts of Effort and Ability Performance Attributions when Coupled with a Fixed Mindset

Dweck and associates caution against having a fixed mindset, person-praise, and ability focused thinking; however, attribution theory and expectancy value theory suggest that attributing successful performance to stable factors like intelligence also lead to strong

motivation and engagement, if not more than if a student were to only attribute their performance to effort alone. As such, depending on what causal attributions a student endorses, a growth mindset might be more or less impactful on student academic outcomes and motivation. Similarly, the impact of a fixed mindset might vary depending on the types of attributions students endorse. The motivational pitfalls of having a fixed mindset have been widely researched and discussed, but the specific impact of students' ability causal attributions, effort causal attributions, and fixed mindsets beliefs on student academic performance and engagement has seldom been discussed.

According to Dweck's model of implicit theories (Dweck & Leggett, 1988) and attribution theory (Weiner, 1972), a person with a fixed mindset and someone who makes stable attributions (e.g., attributing their performance to ability, talent, or intelligence), especially in regards to failures, would believe their abilities were uncontrollable and that there is nothing they can do to increase their intelligence in a given challenging domain. Such a belief could then undermine their motivation. In a similar vein, making ability attributions for one's failures in a challenging course context could cause someone to think that it is more cumbersome or difficult to change their failures into successes because a change in talent would have to preclude this. This may eventually lead to a decline in motivation-related beliefs, such as in subjective task value (the qualities of the task that increase the chances of choosing and valuing the task) and self-concept of ability, leading to the devaluing of a subject domain or a lessened belief that one is good at that subject (Weiner, 1986; Wigfield & Eccles, 2002)—an effect that might be further exacerbated if the student had a fixed mindset instead of a growth mindset. As Eccles and her colleagues have shown, subjective task values and self-concept of ability are closely linked to academic performance—which is one reason why endorsing ability attributions and thinking lack

of ability is the cause of their challenges and difficulties, leads to a decline in achievement (Eccles et al., 1983; Eccles & Wigfield, 2002). Less is known about how endorsing effort attributions may be associated with academic outcomes when the student endorses a fixed mindset. Even though a student may believe their intelligence is not malleable, they may still believe their performance in their courses is due to how much effort they expend, which may protect them from the declines in motivation and achievement typically associated with a fixed mindset. Students with such a belief pattern may think about their intelligence differently compared with other students with a growth mindset—they may realize that working harder and putting forth more effort is why they receive the grades they do but at the same time may not see this as a growth in their overall domain-specific intelligence for that course.

Dweck and colleagues argued that the belief that one's performance is influenced by talent or aptitude can undermine motivation and engagement while championing the belief that academic outcomes are primarily due to effort has only positive effects on motivation. Dweck warns that an obsession with talent and intelligence becomes a detriment to learning and motivation. Although this might hold true when a student considers their academic failures, thinking about their successes in such a way may prove helpful for academic engagement. Furthermore, if a student has a fixed mindset and is not struggling and endorses ability attributions for their academic outcomes, their engagement and motivation may not be undermined because their belief in their abilities is positive and conducive for greater confidence. Although these students do not believe their intelligence can grow or change, they may be perfectly satisfied with the amount of intelligence they have because it allows them the level of achievement they desire; thus, motivation may only be undermined when students feel their fixed intelligence levels are not enough to help them succeed, indicating that the impact of

mindset and attribution beliefs may also depend on students' perceptions of their academic performance as well.

Differential Achievement and Motivation Impacts of Effort and Ability Performance Attributions when Coupled with a Growth Mindset

Mindset theory proponents have suggested that students who endorse a growth mindset and attribute their struggles to unstable factors and endorse effort attributions are less likely to doubt their ability to succeed in the face of failure and more prepared to respond to difficulties with increased effort, leading to higher academic achievement (Henderson & Dweck, 1990). Thus, having a growth mindset and endorsing effort attributions might protect against declines in motivation-related beliefs and achievement. Believing in the power to improve one's competence or intelligence through increased effort may result in greater valuing when the positive associations with their success become associated with their strong efforts (Eccles et al., 1983). I argue, along with other scholars, that attributing academic successes to stable factors may also be adaptive and lead to higher performance because these students will feel more pride in their successful accomplishments, increasing the likelihood that subsequent actions toward achievement will be initiated (Weiner, 1972, Eccles & Wigfield, 2002). Harackiewicz and Elliot (1995) make a compelling argument that perhaps in some instances and for some individuals, understanding effort and talent as the causal roots of one's performance may be more beneficial than only endorsing effort attributions, especially alongside a growth mindset. If a student holds a growth mindset and only attributes their performance to effort attributions, they would not benefit from the positive feedback of their success because they would continue to believe their successes are due mainly to their efforts and not their natural talent or intelligence (Harackiewicz & Elliot, 1995). Wigfield et al. (1997) found a positive relationship between competence-related

beliefs and values, indicating that students will lower their value attached to activities they view as difficult and requiring more effort as an effective way to maintain their self-esteem (e.g. Eccles, 1984; Eccles et al., 1983; Eccles & Wigfield, 2002; Eccles, Wigfield, & Schiefele, 1998; Harter, 1990). Thus, a student who views a course as difficult and thinks that the main reason of their success is their own effort may reduce the value they attach to that subject domain over time. Furthermore, students who endorse a growth mindset along with only effort causal attributions may be less likely to conclude that they are truly talented in a given domain, which may decrease the likelihood that they will pursue either further challenging classes or careers in that subject domain when the effort expenditure they think they will need to expend exceeds what they are willing or able to put forth.

However, if a student endorses a growth mindset and also believes in the idea of natural talents and intellectual aptitude, then attributing one's academic successes, in part, to a fixed entity like talent will lead to increased confidence in one's talent in a subject domain, increased confidence in one's ability to master more difficult material in the future, perhaps increased likelihood of taking additional high-level coursework, and even a greater likelihood of pursuing a career in that field. The general expectancy-value model developed by Eccles, and her colleagues (Eccles, 1983; Eccles et al., 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 1992). Eccles and colleagues proposed that students' achievement-related choices are a function of their expectancy of success (their beliefs about how well they will do) and the subjective value they have for the task. Thus, if a student expects they will do well in a course because they believe their successes can be attributed to their talent in that specific course, this can shape how much they value the course and their self-concept of ability in the course. Students are more inclined to attach more value to activities in which they do well because the positive effect of doing well

becomes attached to the successful activities (Eccles et al., 1983). Thus, students may likely benefit from a strong belief in both their aptitude and efforts because order to fully master the material and continue seeking ways to improve their performance, these students must also have a strong belief in the power of their efforts to further grow their intelligence. This effect may be further strengthened especially when the student also has a growth mindset.

Adapted Mindset Measures for the Present Study

Mindset beliefs have been portrayed as deeply held global beliefs about intelligence, usually phrased as "You have a certain amount of intelligence and there is nothing you can do to change it." However, believing it is possible to improve intelligence in general does not necessarily translate to students believing they can change their own intelligence. Students may hold different beliefs for themselves when taking into consideration their own abilities. Furthermore, personal beliefs about intelligence may be a more powerful predictor of motivation and achievement than general intelligence beliefs. De Castella & Byrne found that a revised first-person measure uniquely explained greater variance in predicted goals, attributions, and academic outcomes, indicating that students' beliefs in their personal ability to improve their intelligence is an even better predictor of achievement and motivation than their general intelligence beliefs. Furthermore, the domain-specificity of the intelligence in question may matter as well. It seems plausible that students' predispositions about their domain-specific intelligence would be more malleable than their predispositions about their general intelligence because their experiences within a specific domain may serve to shape their perceptions of their domain-specific intelligence. The original mindset scale was not domain-specific, and although a few studies have altered the scale to reflect domain-specificity (Burns & Isbell, 2007;

McCutchen et al., 2016; Shively & Ryan, 2013), past research has seldom looked at the domain-specificity of mindset beliefs, especially not in specific courses.

A few studies have revised the original mindset measure to reflect first-person statements (De Castella & Byrne, 2015; Robins & Pals, 2002), but no studies to our knowledge have combined both a first-person and domain-specific contextualization of mindset. Perhaps in order to best understand students' mindset, the measure may benefit from being personalized to the individual, and this personalization may be further deepened when students are asked to think about specific courses they are enrolled in. In order to address this, the present study utilized a new measure that differs from the original items used by Dweck and colleagues on two dimensions—specificity of the subject (i.e., students' self-identified most challenging course) and personalization.

A Pattern-Centered Approach to Mindsets and Attributions

Although mindset theory champions the idea that effort is the primary determinant of success, the present study takes a different approach to illustrate that perhaps believing in both effort and talent are the keys to academic success, engagement, and motivation. Attribution theory and mindset theory have been extensively studied separately, and although some studies have explored the relationship between the two belief systems, we argue that the beliefs regarding the malleability of intelligence are very closely linked to the causal explanations students make for their academic performance, and that they may influence the extent to which a particular mindset impacts academic performance and motivation-related indicators. Specifically, the types of causal performance attributions a student endorses may have a differential impact on motivation and achievement for college students depending on the type of mindset they hold. The pattern-centered approach used in the present study serves to explore how individuals differ

in their endorsement of multiple types of beliefs. It may be the pattern of these beliefs that matter, rather than the unique influence of each construct. For example, it may be the relative pattern of growth mindset beliefs in conjunction with a strong endorsement of both effort and ability attributions that proves to be most fruitful for students' academic performance and motivation. In the present study, we created homogenous subgroups of individuals who have similar belief networks of course-specific mindsets, effort attributions, and ability attributions, and explored the extent to which these patterns are associated with students' motivation-related beliefs regarding their courses (e.g., self-concept of ability and subjective task value) and course grades, overall GPA, and performance perceptions at two time points in the academic quarter (mid-quarter and post-quarter).

Research Purposes

1. Identify growth/fixed mindset and effort/ ability causal performance attribution patterns for undergraduate students during two time points in an academic quarter (mid-quarter and post-quarter)
2. Investigate the extent to which academic performance indicators (course performance and GPA) and motivation-related beliefs differ between:
    a. Individuals who have strong growth mindset beliefs, strong fixed mindset beliefs, or balanced mindset beliefs
    b. Individuals who endorse a growth mindset and only endorse effort performance attributions versus individuals who endorse a growth mindset and both effort and ability performance attributions

3. Investigate the extent to which endorsing effort causal performance attributions protect students who have a fixed mindset from possible low academic performance and motivation-related beliefs that are typically associated with having a fixed mindset

Hypothesized Results

Although there may be several possible patterns that emerge through the proposed analyses, we discuss a few general expected patterns and their hypothesized associations with achievement outcomes and motivation-related beliefs.

1. Growth mindset dominant-Strong effort attributions.

a. Endorsement of growth mindset beliefs: high
b. Endorsement of fixed mindset beliefs: low
c. Endorsement of effort attributions: high
d. Endorsement of ability attributions: low
e. Impact on academic motivation and achievement:
    i. Compared with students who have strong fixed mindset, these students may have stronger self-concept of ability, subjective task value
    ii. In terms of academic performance, these students may experience higher achievement be protected from declines in achievement compared with their peers with fixed mindsets
    iii. Compared with students who have a growth mindset, endorse effort attributions, *and* make strong ability attributions, these students may not have as strong motivation-related beliefs because they may never feel they are truly talented and intelligent in a challenging course domain, lessening

their feelings of competence if they believe most of their performance is due only to their efforts

2. ***Growth mindset dominant- Strong effort and ability attributions.***
    a. Endorsement of growth mindset beliefs: high
    b. Endorsement of fixed mindset beliefs: low
    c. Endorsement of effort attributions: high
    d. Endorsement of ability attributions: high
    e. Impact on academic motivation and achievement:
        i. Compared with students who have strong fixed mindset, these students may have stronger self-concept of ability, and subjective task value
        ii. In terms of academic performance, these students may experience higher achievement be protected from declines in achievement compared with their peers who have fixed mindsets
        iii. Compared with students who have a growth mindset and *only* endorse effort attributions for their successes and failures, students with this belief pattern may attach high task value to their courses, identify more with the course material and see the relevance to their lives, and experience more enjoyment in challenging course contexts. With a strong belief in their own potential to succeed, they may surpass the academic performance of their peers.
3. ***Fixed mindset dominant-Strong ability attributions.***
    a. Endorsement of growth mindset beliefs: low
    b. Endorsement of fixed mindset beliefs: high

c. Endorsement of effort attributions: low

d. Endorsement of ability attributions: high

e. Impact on academic motivation and achievement:

    i. Compared with students who have strong growth mindsets, these students may have weaker self-concept of ability, subjective task value, and lower academic performance

    ii. This belief pattern will be particularly harmful for students who are not performing well and struggling in their courses, leading to less value and less enjoyment in learning contexts compared with other students. In terms of academic performance, these students may experience declines in achievement compared with their peers who have growth mindsets.

    iii. If students are doing well in their course, they may not experience detriments to their academic motivation or achievement, because the positive feedback from their successful academic performance will serve to confirm their intelligence, resulting in feelings of pride and competence

4. Fixed mindset dominant- Strong effort and ability attributions.

a. Endorsement of growth mindset beliefs: low

b. Endorsement of fixed mindset beliefs: high

c. Endorsement of effort attributions: high

d. Endorsement of ability attributions: high

e. Impact on academic motivation and achievement:

    i. If students are not doing well in their courses and are attributing their poor performance to a combination of their abilities and their effort, they may

attach a low value to their courses because of their belief that any action on their part will not serve to increase their overall intelligence; however, their endorsement of effort attributions may push them to figure out ways to improve their grades.

ii. If students are doing well in their courses, they may feel a sense of pride and increased confidence when their intelligence or natural abilities are confirmed.

5. ***Balanced mindset-balanced attributions.***

    a. Endorsement of growth mindset beliefs: moderate
    b. Endorsement of fixed mindset beliefs: moderate
    c. Endorsement of effort attributions: moderate
    d. Endorsement of ability attributions: moderate
    e. Impact on academic motivation and achievement:
        i. Given that little attention has been devoted to the group of students who may not strongly endorse one type of mindset over another, the impact of this belief pattern on student performance outcomes and motivation is exploratory.

Methods

Design

In the fall of 2017, 177 undergraduate students were recruited to join the longitudinal study entitled The Early College Motivation Project. Participants were recruited after the lead researcher visited several undergraduate classes during Week 0-2 of fall quarter. Students were recruited from two biology courses and three education courses in order to recruit students with a

variety of majors. Surveys were administered online three times during the fall quarter in 2017. During each quarter, Wave 1 occurred before participants' midterm exam (Week 3-5), Wave 2 occurred after participants' midterm exam (Week 7-9), and Wave 3 occurred after final exams during the holiday break following the end of the quarter. Participants had two to three weeks to complete each survey. They were compensated for each survey the day after survey was due. The present study utilizes data only from the second and third wave of the study.

Procedure and Participants

I (the lead researcher) visited classes to give a brief presentation about the study to recruit interested freshmen and sophomores. I recruited in two classes in the Biological Sciences department (n=618) and three classes in the Education department (n=355) in order to recruit students with varied majors. The biological sciences classes were non-major courses that are open to anyone at UCI. Two of the education courses were major requirements for education science majors and one was an elective. Students listened to a brief presentation about an overview of the study, eligibility requirements, and compensation. The total number of enrolled students in the five classes was approximately 973 students. Of the 973 students who were presented with the opportunity to join the study, 336 students expressed interest in the study. Interested students signed up on a sign-up sheet and were contacted within a few days with a recruitment survey that allowed them to read the consent form and consent to joining the study. 177 students of the 183 students who completed the recruitment survey were eligible for the study (e.g., they were freshman or sophomores and above age 18), yielding a total recruitment rate of 18%. In the final sample, 48.6% students were recruited from Bio Sci 35: Brain and Behavior, 29.9% were recruited from Bio Sci 36: Drugs and the Brain, 14.1% students were recruited from Education 50: Issues in K-12 Education, 6.8% were recruited from Education 10:

Research Design, and 0.6% were recruited from Education 55: Knowledge and Learning in Math and Science. Students received a personalized link to their first survey during Week 3 of the fall quarter. Students were automatically reminded via email to complete the survey if they had not completed it within seven, ten, and thirteen days of the allotted two-week period. All subsequent surveys were sent via personalized link to students every 3 to 4 weeks.

Analysis Sample Characteristics

The present study included 135 participants from the original cohort of 177 participants. 32 participants were excluded because they did not complete both Wave 2 and Wave 3 of data collection. The average age of participants in the subsample is 18 years and 8 months old. 76% of the sample was female. The ethnic breakdown of the subsample closely matches the overall sample of UCI students (51% Asian, 26% Hispanic/Latino, 10% White, 2% Black, 5% Multiracial-White and Asian, 3% Multiracial-White and Hispanic/Latino, 2% Multiracial-other, and 1% Middle Eastern). 14% of the sample are international students and 56% of students are first generation college students. These numbers are comparable to UCI overall, where 47% of newly enrolled students were first-generation students and 17% of the student body are international students in 2017. 50% of the subsample was designated by university records as low-income. Of the 93% of students who reported their parents' highest level of education, 13% reported one or more parent had less than a high school education, 22% graduated from high school, 10% attended college but did not graduate, 4% attended vocational/technical school, 6% obtained their associate's degree, 26% obtained their bachelor's degree, 15% obtained their master's degree, and 5% obtained an advanced or professional degree. Students' major selections varied in the subsample with 33% choosing a social sciences/social ecology major, 17% education, 4% humanities, 4% computer science, 4% business, 4% public health, 2%

engineering, 2% biological/physical sciences, 2% fine arts, 1% pharmaceutical science, and 27% were undeclared/unaffiliated.

Measures

All measures were pilot tested with former undergraduate students for clarity. Students' course-specific growth mindset and fixed mindset in their hardest course were measured. Students were asked to specify their hardest course in the first survey of the quarter. Their responses were automatically filled into subsequent surveys; however, during the mid-quarter survey, students were asked to confirm that they were still enrolled in the courses that they specified. If they had dropped the first course they specified, they were asked to specify their new hardest course. This response was then automatically inserted into the final survey. In the final survey, it was assumed that students could no longer drop any of their courses because all drop periods had ended before the mid-quarter survey. Thus, the survey did not account for students changing their mind about which course was their hardest and only took into account that they were still enrolled in the class they had specified at the beginning. Only three students dropped their initially reported hardest course. 134 out of 135 students specified their most difficult course: 24% chose a humanities course, 21% chose a biological sciences course, 19% chose a class from the social sciences, 11% chose a math course, 6% chose a social ecology course, 4% chose an information and computer sciences course, 4% chose a physics course, 3% chose an education course, 3% chose a chemistry course, 2% chose a public health course, 2% chose a business course, and 1% chose an earth system science course. See Figure 3.1 for a summary of when each measure used in analysis for the present study was collected.

Mindset scales in the hardest course. The course specific personal versions of the mindset scales were based on the original measure by Dweck and colleagues (Dweck, 2000). De

Castella and Byrne (2015) revised the original mindset scale to create a self-theory scale in which the original items were re-worded so that each statement reflects a first-person claim about the extent to which intelligence is fixed or malleable. I further revised the self-theory scale to make each statement specific to the most difficult course, as specified by the student. Efforts were made to ensure that the items aligned closely with the original mindset items. Students were told to rate the extent to which they agreed with each statement on a Likert scale of 1-6 (1 = *Strongly disagree*; 6 = *Strongly agree*). The Wave 2 (mid-quarter) and Wave 3 (post-quarter) course-specific mindsets were used for analysis.

Fixed mindset in the hardest course. The fixed mindset scale contains three items that indicate how much a student believes in the fixedness of their own intelligence in their most difficult course (e.g., I can learn new things in this course, but I don't have the ability to change my basic intelligence in this course). Strong agreement with this scale would indicate that a student believes their own intelligence is fixed in a specific course. (1= *Strongly disagree* to 6 = *Strongly agree*; Wave 2: α = .90; Wave 3: α = .94).

Growth mindset in the hardest course. The growth mindset scale contains three items that indicate how much a student believes in the malleability of their own intelligence in their most difficult course (e.g., "Regardless of my current intelligence level in this course, I think I have the capacity to change it quite a bit"). Strong agreement with this scale would indicate that a student believes they can change their own intelligence in a specific course. (1= *Strongly disagree* to 6 = *Strongly agree*; Wave 2: α = .95; Wave 3: α = .95).

Attributions. Students were asked to consider how important a causal factor was in determining their performance on their midterm and final exam in their most difficult course. Items were adapted from previous attribution measures (Elig & Frieze, 1979). Students were

asked to respond on a 5-point Likert scale, ranging from 1 (not at all important) to 5 (very important). Attributions about students' performance on their midterm and final exam in their most difficult course were assessed during the second and third time point of each quarter. Six causal statements were presented to students after they rated how well they felt they did on their midterm/final exam of their most difficult course (e.g., "You indicated that you did very well/well/fair/poor/very poor on your midterm of your most difficult course. Please indicate how importance the following reasons were for your performance."). The items belonged to two causal categories: effort and ability.

Effort attributions. Three items reflected causal statements regarding how much effort the student put forth for the midterm/final. The items were: "The amount of effort you put into studying the course material," "The amount of time you spent studying the course material," and "How hard you worked in the course," (Wave 2: $\alpha = .80$; Wave 3: $\alpha = .77$).

Ability attributions. Three items reflected causal statements regarding how much ability or intelligence the student possessed. The items were: "The amount of talent you have in the subject matter," "The amount of intelligence you have," and "The amount of academic ability of skill you have in this course," (Wave 2: $\alpha = .80$; Wave 3: $\alpha = .74$).

Motivation-Related Beliefs. Several types of motivation-related beliefs were assessed with scales adapted from existing well-establish scales tested in previous studies, which were developed to assess constructs central to Expectancy-Value Theory (Eccles et al., 1983; Eccles et al., 1989). Motivation-related beliefs were assessed at mid-quarter (Wave 2). The factor structure of each scale was confirmed with confirmatory factor analysis in Stata 22. See Appendix 3.1 for a complete list of items and Appendix 3.2 for a summary of the CFA and factor loadings.

Self-concept of ability for hardest course. Students' self-concept of ability was assessed with four items developed from the work of Eccles, Adler, and Meece (1984) during the mid-quarter survey. Students were assessed on their personal beliefs about their academic abilities and asked to rate their self-concept of ability specific to their hardest course. The measure included items such as, "How good are you at the subject matter in your most difficult course?" (1 = *not at all good* to 5 = *outstandingly good*; α = .79).

Subjective task value for hardest course. Students' subjective task value was assessed with four separate scales that tapped into the four components of positive and negative valence for a task: attainment value (importance for identity), utility value (usefulness), intrinsic value (interest), and cost (the loss of time or another valued alternative). The scales were based on existing widely-used scales from previous studies (Eccles et al., 1993; Eccles & Wigfield, 1995; Wigfield et al., 1997).

Attainment value. Students' attainment value was assessed with three items. The measure included items such as, "Being good at the subject material in my most difficult course is an important part of who I am." (1 = *not at all true for me* to 5 = *very true for me*; α = .87).

Utility value. Students' utility value was assessed with four items. The measure included items such as, "The subject material in my most difficult course will be useful for me later in life." (1 = *not at all true for me* to 5 = *very true for me*; α = .90).

Intrinsic value. Students' intrinsic value was assessed with four items. The measure included items such as, "I enjoy doing work for my most difficult course." (1 = *not at all true for me* to 5 = *very true for me*; α = .94).

Cost. Students' cost was assessed with four items. The measure included items such as, "I have to give up a lot to do well in my most difficult course." (1 = *not at all true for me* to 5 =

very true for me; α = .77).

Academic Performance Measures. Students' academic performance was measured through their exam grades, end-of-course grades, overall GPA, and their perceptions of their performance on the midterm/final exam of their hardest course.

Exam grades. Students' were asked to report the letter grade they received on their midterm and final exam. Because some students had not received their grades before taking the survey, we only have self-reported grades for 82 out of 135 students (61% response rate). Letter grades were converted to numerical grades as follows: A+/A = 4.0, A- = 3.7, B+ = 3.3, B = 3.0, B- = 2.7, C+ = 2.3, C = 2.0, C- = 1.7, D+ = 1.3, D = 1.0, D- = 0.7, F = 0. Two exam grades were utilized to understand how mindset-attribution patterns were associated with the change in grades from midterm to final exam.

Course grades. Students' course grades were obtained from the university registrar. Letter grades were converted to numerical grades as follows: A+/A = 4.0, A- = 3.7, B+ = 3.3, B = 3.0, B- = 2.7, C+ = 2.3, C = 2.0, C- = 1.7, D+ = 1.3, D = 1.0, D- = 0.7, F = 0. The mean letter grade was M = 3.06 (SD = 1.00), which is a grade between a B and B+.

Overall GPA. Students' overall GPA was obtained from the university registrar. The present study utilized end-of-quarter GPA for all participants, which might be different than cumulative GPA for students who had attended the university before fall quarter. GPA was measured on a scale of 0-4.

Perceptions of Performance. Students were asked to consider how well they felt they performed on the midterm and the final exam of their hardest course during the second and third survey. A single item asked, "How well do you feel you did on the first exam or midterm/ final exam in your most difficult course?" Students rated their response on 5-point Likert scale,

ranging from 1 (very poor) to 5 (very well). Perceptions of midterm performance was collapsed into three subgroups: poor, fair, and well, with "poor" indicated by scores of 1 (very poor) and 2 (poor), "fair" indicated by a score of 3, and "well" indicated by scores of 4 (well), and 5 (very well). Regarding their midterm exam, 24% indicated they performed poorly, 31% indicated they performed fairly, and 45% reported they performed well. Regarding their final exam, 16% of students indicated they performed poorly, 36% reported they performed fairly, and 48% of students indicated they performed well.

Analysis Plan

Confirmatory factor analysis (CFA). I used CFA to verify the factor structure of the course-specific mindset scale, effort attributions, and ability attributions at mid-quarter and post-quarter. Given that the course-specific mindset scale is an adaptation of the well-established mindset scale developed by Dweck and colleagues, it was important to test the hypothesis that the underlying latent constructs of a growth mindset and fixed mindset exist for the adapted scales. The attribution items have been adapted from previous measures. Given that students may understand terms such as ability and talent differently, it was essential to make sure that each scale is measuring the intended construct. Structural equation modeling was used, relying on several statistical tests to determine the adequacy of the model fit to the data (e.g., chi-square test, comparative fit index, and RMSEA).

Pattern centered analysis. Cluster analysis is a pattern-centered technique in which individuals are put into homogeneous groups based on the pattern of their responses to clustering variables (see Bergman et al., 2003). Cluster analysis was used to uncover patterns in course-specific growth mindset, course-specific fixed mindset, effort attributions, and ability

attributions. All four variables were clustered together at mid-quarter (Wave 2) and post-quarter (Wave 3), for a total of two separate cluster analyses:

1. Mid-quarter pattern of course-specific growth and fixed mindset-effort and ability attributions
2. Post-quarter pattern of course-specific growth and fixed mindset-effort and ability attributions

Following our theoretical framework, we clustered the course-specific mindset and attributions together because they operate at similar psychological levels. This is because they both regard the same context (the student's self-reported hardest class). Students are likely to think about the malleability of their intelligence in a specific course and their causal understandings for their performance in that course in similar ways. Following the steps of pattern-centered analysis delineated by Bergman et al. (2003) and Vargha, Torma, and Bergman (2015), I used the ROPstat statistical package (www.ropstat.com). The advantage of this procedure is that it makes no assumptions about the distributions of the responses on the measures. I used a set of modules in ROPstat that comprise four steps for uncovering patterns that include analyzing and imputing missing data, identifying and removing residue multivariate outliers, deciding on an optimal number of clusters, and relocating cases to better-fitting clusters (Vargha et al., 2015; Bergman et al., 2003). The optimal number of cluster solutions was determined using a scree-type plot identified the statistically justifiable upper and lower number of cluster groups utilizing the error sum of squares (ESS) of solutions ranging from 2 to 20 clusters. Theoretical considerations were also be used as criteria to decide upon the optimal number of clusters. K-means relocation improved the quality of the optimal cluster solution by moving cases to better-fitting clusters.

Linking mindset clusters from mid-quarter to post-quarter. In order to compare cluster membership at two time points during the academic quarter, the mid-quarter patterns

were compared to the post-quarter patterns, using the LICUR (Linking of Clusters after removal of a Residue) method (Bergman et al., 2003). Separate cross-sectional cluster analyses were performed on each set of variables at each time point and then the resulting classifications are linked. The goal of LICUR is to provide a basic analysis of pattern development from an inter-individual perspective using a snap-snot linking approach (Bergman et al., 2003). The clusters were compared across both time points for structural stability (are there similar profiles at the beginning and end of the quarter?) and individual stability (do students tend to stay in the same cluster across the quarter?).

The first step of the LICUR procedure, as outlined by Bergman et al. (2003), is to identify a residue separately at each time point. The second step is to cluster analyze the subjects separately at each time point. The third step is to relate the classification at adjacent ages to one another by cross-tabulation of time-adjoining classifications and test for significant types of cluster membership combinations using exact cellwise tests. Testing for significant cluster combinations—overrepresented or underrepresented cells—can be problematic using ordinary chi-square-based statistics, as the normal approximations are not accurate. Bergman et al. (2003) advise to use exact cellwise tests and an improved Bonferroni correction approach known as Holm's procedure to adjust the nominal significance levels.

Association of clusters with motivation-related beliefs and academic performance indicators. Analysis of covariance (ANCOVA) techniques and Chi-square analyses were used to explore the extent to which mid-quarter and post-quarter clusters differed in course-related motivation beliefs (e.g., self-concept of ability and subjective task value indicators) and academic performance indicators (exam grades, course grades, GPA, and performance

perceptions). Bonferroni corrected pairwise contrasts between the clusters revealed which patterns were more or less adaptive.

Handling Missing Data

No one in the analysis sample was missing data on any of the key mindset or motivation-related variables. Listwise deletion occurred for less than 1% of participants who were missing data on the attribution variables. Listwise deletion was used in this case because it introduces the smallest amount of bias. Thirty-two participants were excluded because they did not complete surveys for both Wave 2 and Wave 3. Independent-samples t-tests and chi-square test for independence determined that those individuals who were dropped from the analysis sample did not significantly differ from those with complete data on demographic or university data. Independent-samples t-tests were conducted to compare the course grades and end of quarter GPA and age for those missing data and those with complete data. There was no significant difference in course grades (on a scale of 0 to 4.0) for those who were missing (M = 2.51, SD = 1.52) and those who had complete data (*M* = 3.06, *SD* = .99); t (139) = -1.37, *p* = .17 (two-tailed). There was no significant difference in end of quarter GPA (on a scale of 0 to 4.0) for those who were missing data (*M* = 2.95, *SD* = .82) and those who had complete data. There was no significant difference in age for those who were missing data (*M* = 18.68, *SD* = .63) and those who had complete data (*M* = 18.63, *SD* = .57); t (155) = .40, p = .69 (two-tailed). The magnitude of differences in the means (mean difference = .05, 95% CI: -.20 to .30) was very small (eta squared = 0.001).

Independent-samples t-tests also determined that those individuals who were dropped from the analysis sample did not significantly differ from those with complete data on any of the motivation-related beliefs collected during mid-quarter. There was no significant difference in

self-concept of ability for those who were missing (M = 2.57, SD = .83) and those who had complete data (M = 2.78, SD = .69); t (151) = -1.19, p = .24 (two-tailed). There was no significant difference in attainment value for those who were missing (M = 2.63, SD = 1.15), and those who had complete data (M = 3.09, SD = 1.13); t (151) = -1.63, p = .11 (two-tailed). There was no significant difference in utility value for those who were missing (M = 2.69, SD = 1.01) and those who had complete data (M = 2.91, SD = 1.16); t (151) = -.74, p = .46 (two-tailed). There was no significant difference in intrinsic value for those who were missing (M = 2.62, SD = .83) and those who had complete data (M = 2.67, SD = 1.12); t (150) = -.20, p = .85 (two-tailed). There was no significant difference in cost for those who were missing (M = 3.76, SD = .73) and those who had complete data (M = 3.40, SD = .83); t (150) = 1.71, p = .09 (two-tailed). Chi-square tests for independence (with Yates Continuity Correction) indicated no significant associations between students who are missing and students who have complete data on the following variables: gender, χ^2 (1, n = 167) = 1.03, p = .31, phi = -.10; class level, χ^2 (1, n = 167) = .11, p = .74, phi =.04; low-income status, χ^2 (1, n = 167) = 0, p = 1, phi = -.003; international student status, χ^2 (1, n = 167) = .15, p = .70, phi = -.05; and college generation status, χ^2 (1, n = 163) = 1.03, p = .31, phi = -.10. Chi-square tests for independence also indicated no significant associations between missing status and: race/ethnicity, χ^2 (7, n = 157) = 5.06, p = .65, phi =.18; highest level of parent's education, χ^2 (7, n = 149) = 14.01, p = .051, phi = .31; and college major, χ^2 (13, n = 161) = 15.41, p = .28, phi = .31.

Results

Confirmatory Factor Analysis (CFA)

I conducted two separate confirmatory factor analyses to verify the factor structure of the mindset and attribution scales at Wave 2 and Wave 3 using structural equation modeling

software in Stata 22 and relying on several statistical tests to determine the adequacy of the model fit to the data (e.g., chi-square test, comparative fit index, and RMSEA). Given that the course-specific mindset scale and the attribution scales are adaptations of well-established scales, it was necessary to test the hypothesis that the underlying latent constructs of a growth mindset, fixed mindset, effort attributions, and ability attributions exist for the adapted scales as well. Model 1 measured growth mindset, fixed mindsets, effort attributions, and ability attributions at Wave 2. Model 2 measured growth mindset, fixed mindset, effort attributions, and ability attributions at Wave 3. I hypothesized the two four-factor models to be confirmed in the measurement portion of the model after evaluating the assumptions of univariate and multivariate normality and linearity through SPSS 13. Less than one percent of data was missing on three attribution items and no one was missing data for the mindset variables; thus, maximum likelihood with missing values was used for the estimation and all 135 participants were included in both models. Model 1 measured four factors in Wave 2: growth mindset, fixed mindset, effort attributions, and ability attributions. Model 2 measured four factors in Wave 3: growth mindset, fixed mindset, effort attributions, and ability attributions. For Model 1, χ^2 (48, n = 135) = 81.76, p = .002, the comparative fit index (CFI) = .97, the Tucker-Lewis fit index (TLI) = .96, and the RMSEA = .07. The four-factor model was an improvement from the baseline model, which only included two factors (i.e., all mindset indicators were included in one latent variable and all attribution indicators were included in a second latent variable), χ^2 (53, n = 135) = 308.30, p < .001, CFI = .74, TLI = .68, and RMSEA = .19. For Model 2, χ^2 (48, n = 135) = 67.62, p = .03, CFI = .98, TLI = .98, and the RMSEA = .06. The four-factor model was an improvement from the two-factor baseline model, χ^2 (53, n = 135) = 341.91, p < .001, CFI = .70, TLI = .63, and RMSEA =.20. Goodness of fit indicators for both final models indicate a better fit between the

model and the observed data, indicating a considerable improvement from the baseline models. Standardized and unstandardized parameter estimates for each final model are provided in Table 3.1.

Descriptive Summary

I examined the key mindset and attribution variables at a descriptive level. Means were skewed downward for course-specific fixed mindset (Wave 2: *M* = 2.81, *SD* = 1.13; Wave 3: *M* = 2.91, *SD* = 1.24) and skewed upward for course-specific growth mindsets (Wave 2: *M* = 4.64, *SD* = 1.05; Wave 3: *M* = 4.62, *SD* = 1.05). On average, students made stronger effort attributions (Wave 2: *M* = 4.08, *SD* = .78; Wave 3: *M* = 4.08; *SD* = .76) than ability attributions (Wave 2: *M* = 3.11, *SD* = .95; Wave 3: *M* = 3.10; *SD* = .86) at both time points. A correlation matrix for the key variables is provided in Table 3.2. Growth mindsets at mid-quarter were positively associated with growth mindsets made at the end of the quarter (*r* = .51) Fixed mindsets at mid-quarter were positively associated with fixed mindsets made at the end of the quarter (r = .59). At both waves, stronger growth mindsets were associated with weaker fixed mindsets (Wave 2: *r* = -.74; Wave 3: *r* = -.63). At mid-quarter, stronger fixed mindsets were negatively associated with effort attributions (*r* = -.28), and stronger growth mindsets were positively associated with effort attributions (*r* = .25). At post-quarter, stronger fixed mindsets were negatively associated with effort attributions (*r* = -.18), and stronger growth mindsets were positively associated with effort attributions (*r* = .27). At post-quarter, fixed mindsets were positively correlated with ability attributions (*r* = .24). Effort attributions made at mid-quarter were positively associated with effort attributions made at the end of the quarter (*r* = .42). Ability attributions at mid-quarter were positively associated with ability attributions made at the end of the quarter (*r* = .59).

In general, motivation-related beliefs were positively correlated with a growth mindset, effort attributions, and ability attributions, and negatively correlated with a fixed mindset. Having a fixed mindset at mid-quarter and post-quarter was moderately negatively associated with attainment value (Wave 2: r = -.28; Wave 3: r = -.24) and intrinsic value (Wave 2: r = -.33; Wave 3: r = -.32). Fixed mindsets at post-quarter were also negatively associated with utility value (r = -.31) and weakly negatively associated with perceptions of midterm performance (r = -.18). Having a growth mindset at mid-quarter and post-quarter was positively associated with attainment value (Wave 2: r = .19; Wave 3: r = .23) and intrinsic value (Wave 2: r = .21; Wave 3: r = .26), and post-quarter growth mindsets were also positively associated with utility value (r = .20). Effort performance attributions at mid-quarter and post-quarter were moderately positively correlated with attainment value (Wave 2: r = .39; Wave 3: r = .30), utility value (Wave 2: r = .19; Wave 3: r = .17), and cost (Wave 2: r = .34; Wave 3: r = .25), and effort performance attributions at post-quarter were also positively associated with intrinsic value (r = .23). Mid-quarter and post-quarter ability attributions were positively associated with attainment value (Wave 2: r = .19; Wave 3: r = .21) and utility value (Wave 2: r = .21; Wave 3: r = .26), and post-quarter ability attributions were also positively associated with intrinsic value (r = .17) and cost (r = .31). Self-concept of ability, attainment value, utility value, and intrinsic value were moderately correlated with each other. Self-concept of ability was moderately correlated with exam grades (midterm: r = .69; final: r = .49), course grades (r = .48), GPA (r = .34), and performance perceptions of the midterm (r = .63) and final exam (r = .38). In general, self-reported midterm and final exam grades were strongly positively correlated with course grades (midterm: r = .71; final: r = .73), and performance perceptions for each exam, respectively (midterm: r = .74; final: r = .68). Course grades were moderately correlated with students'

perceptions of their performance on their midterm (r = .56) and final exam (r = .47) and strongly correlated with their overall GPA at the end of the quarter (r = .72). None of the mindset variables or attribution variables were associated with exam grades, course grades, end of quarter GPA, or perceptions of performance on the midterm or final exam.

Pattern Centered Analysis

Cluster analysis was used to identify patterns in students' fixed/growth mindset and effort/ability attributions. Two separate cluster analyses were conducted for mid-quarter (Wave2) and post-quarter (Wave 3).

1. Variables included at mid-quarter: Fixed mindset, growth mindset, effort attributions, ability attributions
2. Variables included at post-quarter: Fixed mindset, growth mindset, effort attributions, ability attributions

The initial steps of cluster analysis resulted in scree-type plots (see Appendix Figure 3.1 for plots) that indicated a statistical justification based on the trend of ESS values for selecting as few as four or as many as six cluster groups for each separate analysis. The homogeneity coefficients (HC) of each cluster indicate how homogenous each cluster is relative to the overall sample (Vargha et al., 2015). Each HC of the clusters in the optimal solutions was below the HC of the overall sample, indicating that the clusters are more homogenous than the overall sample and that we have found relatively homogenous subgroups in the cluster solutions. Multivariate outliers were removed prior to each cluster analysis. Because different beliefs were grouped together for each cluster analysis, a multivariate outlier for one wave may not be considered an outlier for the other wave. Generally, the optimal solution retained a sizable percentage of the sample (e.g., at least 10%) within each cluster. The optimal solution also exemplified

theoretically distinct and unique profiles. A brief summary of how the optimal number of cluster solutions was chosen and information on multivariate outliers for each analysis is described.

1. Wave 2: The ESS plot indicated that there was theoretical justification for the optimal number of clusters to be as few as 4 or as many as 6 clusters. The 4-cluster solution displayed theoretically distinct profiles. The 5- and 6-cluster solutions had clusters that were comprised of less than ten percent of the sample, making the 4-cluster solution the optimal choice.
2. Wave 3: The ESS plot indicated that the optimal number of clusters was as few as 4 or as many as 6 clusters. The 4-cluster solution displayed theoretically distinct profiles. The 5- and 6-cluster solutions did not add any other additional interesting patterns and did not retain at least ten percent of the sample within each cluster, making the 4-cluster solution the optimal choice.

Mindset and Attributions Patterns

The two sets of cluster analyses indicated that there are several different ways students endorse their fixed and growth mindset beliefs relative to their effort and ability attributions. Similar patterns emerged at mid-quarter and at the end of quarter. Wave 2 cluster analysis revealed a High Growth Mindset/ High Effort Attribution (High GM/ High EA) cluster, High Growth Mindset/ Moderately High Effort and Ability Attributions (High GM/Mod-High EA & AA) cluster, High Fixed Mindset/ Moderate Effort and Ability Attributions (High FM/ Mod EA & AA) cluster, and Moderately High Growth Mindset/ Moderate Fixed Mindset/ Moderately Low Effort and Ability Attributions (Mod-High GM/ Mod FM/ Low-Mod EA & AA) cluster. See Figure 3.2 and Figure 3.3 for unstandardized and standardized means of the optimal cluster solution at Wave 2. Wave 3 cluster analysis revealed a High Growth Mindset/ High Effort Attributions (High GM/ High EA) cluster, High Growth Mindset/ High Effort and Ability Attributions cluster (High GM/ High EA & AA), High Fixed Mindset/High Effort

Attributions/Moderate Ability Attributions (High FM/ High EA/ Mod AA), and Moderate Growth and Fixed Mindset/Moderate Effort and Ability Attributions (Mod FM & GM/ Mod EA & AA) cluster. See Figure 3.4 and Figure 3.5 for unstandardized and standardized means of the optimal cluster solution at Wave 3. Although some of the patterns were the same, the mindset-attributions patterns in Wave 2 differed somewhat from the patterns that emerged at the end of the quarter (Wave 3). At mid-quarter, 26% of students were in the High GM/ High EA profile, 36% of students were in the High GM/ Mod-High EA & AA profile, 19% of students were in the High FM/ Mod EA & AA profile, and 19% of students were in the Mod-High GM/ Mod FM/ Low-Mod EA profile. By the end of the quarter, 26% of students were in the High GM/ High EA profile, 23% of students were in the High GM/ High EA & AA profile, 20% of students were in the High FM/ High EA/ Mod AA profile, and 30% of students were in the Mod FM & GM/ Mod EA & AA profile. Based on the percentages alone, it appeared more students had more moderate views by the end of the quarter compared to the beginning of the quarter.

Mid-Quarter Profiles

Cluster 1: High Growth Mindset/ High Effort Attribution (High GM/ High EA). The high growth mindset/ high effort attribution pattern (n = 35; HC: 0.58) comprised students who had the strongest agreement with growth mindset beliefs (M = 5.32) and strongest disagreement with fixed mindset beliefs (M = 2.00). They also gave the highest importance to their effort performance attributions (M = 4.62) and lowest importance to their ability performance attributions (M = 2.28) compared with all other groups.

Cluster 2: High Growth Mindset/ Moderately High Effort and Ability Attributions (High GM/ Mod-High EA & AA). The high growth mindset/ moderately high effort and ability attributions pattern (n = 48; HC: 0.86) included students with strong growth mindset beliefs (M =

4.99), weak fixed mindset beliefs (*M* = 2.47), moderately high effort attributions (*M* = 4.31), and moderately high ability attributions (*M* = 3.92). Compared with all other groups, students in this profile gave the strongest importance to ability attributions. Students in this profile endorsed a strong growth mindset and gave nearly equal importance to their effort and ability performance attributions. This pattern had the greatest number of students, including a little over one-third of the sample.

Cluster 3: High Fixed Mindset/ Moderate Effort and Ability Attributions (High FM/ Mod EA & AA). The high fixed mindset/ moderate effort and ability attribution pattern (*n* = 25; HC: 1.83) was composed of students who had the strongest fixed mindset beliefs (*M* = 4.49) and the weakest growth mindset beliefs (*M* = 3.29). It is important to note that even though students in this cluster had the weakest growth mindset beliefs compared with other students, their average score indicates a moderate endorsement of a growth mindset, nonetheless. Students in the High FM/ Mod EA & AA cluster made moderate effort attributions (*M* = 3.87) and moderate ability attributions (*M*= 3.04).

Cluster 4: Moderately High Growth Mindset/ Moderate Fixed Mindset/ Moderately Low Effort and Ability Attributions (Mod-High GM/ Mod FM/ Low-Mod EA & AA). The moderately high growth mindset/ moderate fixed mindset/ moderately low effort and ability attributions pattern (*n* = 25; HC: 0.88) was composed of students who had moderately high agreement with growth mindset beliefs (*M* = 4.63), moderate agreement with fixed mindset beliefs (*M* = 2.83), moderately low effort attributions (M = 3.12), and moderately low ability attributions (M = 2.71). Students in this profile gave about equally moderately low importance to both effort and ability performance attributions, indicating they may attribute their performance to other types of factors.

Post-Quarter Profiles

Cluster 1: High Growth Mindset/ High Effort Attribution (High GM/ High EA). The high growth mindset/ high effort attribution pattern (*n* = 35; HC: 0.68) included students who had strong agreement with growth mindset beliefs (*M* = 5.31) and the strongest disagreement with fixed mindset beliefs (*M* = 2.00). They also gave the highest importance to their effort performance attributions (*M* = 4.51) and lowest importance to their ability performance attributions (*M* = 2.26) compared with all other groups. This cluster is structurally similar to mid-quarter Cluster 1.

Cluster 2: High Growth Mindset/ High Effort and Ability Attributions cluster (High GM/ High EA & AA). The high growth mindset/ high effort and ability attribution cluster (*n* = 31; HC: 0.80) was composed of students who had the strongest agreement with growth mindset beliefs (*M* = 5.37), weak agreement with fixed mindset beliefs (*M* = 2.26), strong endorsement of effort attributions (M = 4.43), and the strongest endorsement of ability attributions compared with all other groups (M = 4.02). This cluster is structurally similar to mid-quarter Cluster 2, with slightly stronger endorsement of effort and ability performance attributions at post-quarter.

Cluster 3: High Fixed Mindset/High Effort Attributions/Moderate Ability Attributions (High FM/ High EA/ Mod AA). The high fixed mindset/high effort attributions/moderate ability attributions cluster (*n* = 27; HC: 1.25) included students who had the strongest agreement with fixed mindset beliefs (M = 4.33), moderate agreement with growth mindset beliefs (M = 3.52), high endorsement of effort performance attributions (M = 4.49), and moderate endorsement of ability attributions (M = 3.38). Although their beliefs were moderate, this group of students had the weakest growth mindset beliefs. This cluster is structurally similar

to mid-quarter Cluster 3, with slightly stronger endorsement of effort performance attributions at post-quarter.

Cluster 4: Moderate Growth and Fixed Mindset/Moderate Effort/ Moderately Low Ability Attributions (Mod FM & GM/ Mod EA/ Low-Mod AA). The moderate growth and fixed mindset/moderate effort and ability attributions cluster (n = 40; HC: 1.05) was composed of students who had moderate growth mindset beliefs (M = 4.22), moderate fixed mindset beliefs (M = 3.21), moderate effort attributions (M = 3.25), and moderately low ability attributions (M = 2.93). Students in this cluster had among the weakest growth mindset beliefs and effort performance attributions compared with other groups. The Mod FM & GM/ Mod EA/ Low-Mod AA cluster had the largest number of students at post-quarter. This cluster is structurally similar to mid-quarter Cluster 4, with stronger fixed mindset beliefs.

Linking Mindset Clusters Across an Academic Quarter

Mid-quarter patterns were compared with post-quarter using the LICUR (Linking of Clusters after removal of a Residue) method (Bergman et al., 2003). LICUR takes an inter-individual perspective using a snapshot linking approach. The cluster analyses classifications were linked to each other through cross-tabulation and cellwise tests. Chi-square tests of significance and *post hoc* residual cell-wise analysis (as recommended by Bergman et al., 2003; see Beasley & Schumacker, 1995) were used to explore significant overrepresented and underrepresented cluster combinations. Table 3.3 displays the frequencies of statistically significant cluster transitions.

Forty-six percent of students maintained a similar profile across the academic quarter; however, it is important to note although the relative shape of the profile was similar, some differed at the mean level. Pearson's Chi-square test revealed statistically significant cluster

linkages, $\chi^2(9) = 43.41$, $p < .001$. *Post hoc* residual cell-wise analysis revealed that there was considerable individual stability in mindsets-attribution patterns from the beginning of the quarter to the end of the quarter, indicating that students were likely to maintain relatively similar beliefs from the middle of the quarter to the end of the quarter. Cluster linkages that were statistically significantly overrepresented included remaining in Cluster 1, Cluster 2, and Cluster 3, indicating that there were significantly more students who, for the most part, maintained their mindset attribution belief pattern over time. Students who were in the Mod-High GM/ Mod FM/ Low-Mod EA & AA cluster at mid-quarter were not statistically significantly more likely to transition to any one type of cluster in particular, but most of them were in the Mod FM & GM/ Mod EA/ Low-Mod AA cluster at the end of the quarter. These students were characterized by slightly stronger fixed mindset beliefs, ability, and effort performance attributions, and slightly weaker growth mindset beliefs. Overall, students who had stronger mindset beliefs (e.g., Clusters 1, 2, and 3), especially when one type of mindset belief was much stronger than the other, were more likely to maintain the strength of their beliefs and the relative disparity between their growth mindset and fixed mindset beliefs.

Factors Associated with Changing Mindsets

Follow-up analyses were conducted in order to highlight what factors might be associated with students changing their mindsets. Students' pattern shifts were recoded into six categories of either maintaining their views or shifting to a different mindset: 1. Remained GM (n = 52), 2. Remained FM (n=10), 3. Remained Mod (n=10), 4. Shifted to GM (n=13), 5. Shifted to FM (n=16), and 6. Shifted to Mod (n=30). (Note that students who either remained in Cluster 1 (High GM/High EA) or Cluster 2 (High GM/High EA & AA) or shifted between the two groups were grouped into category 1 because both clusters had strong agreement with growth mindset

beliefs). Using univariate ANCOVA, several motivation-related and course performance indicators were explored in association with the pattern shift (see Appendix Table 3.1 for summary of additional analyses); however, only utility value ($F(5, 125) = 4.92$, $p < .001$, partial eta squared = .16) and attainment value ($F(5, 125) = 5.60$, $p < .001$, partial eta squared = .18) were statistically significantly associated with students' mindset pattern transition. Students who maintained their growth mindset beliefs ($M = 3.45$, $SE = .15$) saw greater relevance (e.g., utility value) in their courses compared with students who shifted toward more fixed mindset beliefs ($M = 2.23$, $SE = .27$). Students who maintained their growth mindset beliefs ($M = 3.61$, $SE = .14$) were more likely to believe the work in their hardest course was important for their identity compared with students who maintained moderate mindset beliefs ($M = 2.10$, $SE = .32$).

Cluster Associations with Course-Related Motivation Beliefs

Using univariate ANCOVA, I examined the extent to which cluster group membership was associated with several motivation-related beliefs regarding students' hardest course (i.e., self-concept of ability, attainment value, utility value, intrinsic value, and cost). See Table 3.4 for a summary of the analyses. Table 3.5 and Table 3.6 display means and pairwise comparisons for each analysis.

Self-concept of ability. There was a statistically significant association between mid-quarter cluster membership and students' self-concept of ability regarding their hardest course, Mid-quarter: $F(3, 129) = 2.72$, $p = .05$, partial eta squared = .06. At mid-quarter, self-concept of ability for the hardest course was higher in Cluster 2 (High GM/ High EA & AA) compared with Cluster 3 (High FM/ Mod EA & AA). There was not a statistically significant association between post-quarter cluster membership and self-concept of ability, Post-quarter: $F(3, 129) = 1.48$, $p = .22$, partial eta squared = .03.

Attainment value. There was a statistically significant association between cluster membership and students' attainment value regarding their hardest course, Mid-quarter: $F(3, 129) = 12.36$, $p < .001$, partial eta squared = .22; Post-quarter: $F(3, 129) = 5.39$, $p = .002$, partial eta squared = .11. At mid-quarter, attainment value was higher in Cluster 1(High GM/ High EA) and Cluster 2 (High GM/ High EA & AA) compared with Cluster 4 (Mod-High GM/ Mod FM/ Low-Mod EA & AA). Cluster 2 had statistically significantly higher attainment value than Cluster 3 (High FM/ Mod EA & AA). At post-quarter, attainment value was higher in Cluster 2 (High GM/ High EA & AA) compared with Cluster 3 (High FM/ High EA/ Mod AA) and Cluster 4 (Mod FM & GM/ Mod EA/ Low-Mod AA).

Utility value. There was a statistically significant association between mid-quarter and post-quarter cluster membership and students' attainment value regarding their hardest course, Mid-quarter: $F(3, 129) = 4.29$, $p = .01$, partial eta squared = .09; Post-quarter: $F(3, 129) = 9.39$, $p < .001$, partial eta squared = .16. At mid-quarter, utility value in Cluster 2 (High GM/ Mod-High EA & AA) was statistically significantly higher than Cluster 4 (Mod-High GM/ Mod FM/ Low-Mod EA & AA). Utility value for post-quarter Cluster 2 (High GM/ High EA & AA) was statistically significantly higher than all other clusters.

Intrinsic value. There was a statistically significant association between mid-quarter and post-quarter cluster membership and students' intrinsic value regarding their hardest course, Mid-quarter: $F(3, 129) = 4.02$, $p = .01$, partial eta squared = .09; Post-Quarter: $F(3, 129) = 5.78$, $p = .001$, partial eta squared = .12. At mid-quarter, intrinsic value in Cluster 1 (High GM/ High EA) and Cluster 2 (High GM/ High EA & AA) was higher than Cluster 3 (High FM/ Mod EA & AA). At post-quarter, intrinsic value in Cluster 2 (High GM/ High EA & AA) was higher than

Cluster 3 (High FM/ High EA/ Mod AA) and Cluster 4 (Mod FM & GM/ Mod EA/ Low-Mod AA).

Cost. There was not a statistically significant association between cluster membership and students' self-concept of ability regarding their hardest course, Mid-quarter: $F(3, 129) = 2.59$, $p = .06$, partial eta squared = .06; Post-quarter: $F(3, 129) = 2.17$, $p = .10$, partial eta squared = .05.

Cluster Associations with Course Performance, GPA, and Performance Perceptions

To assess the extent to which mid-quarter clusters predicted changes in exam grades from the midterm to the final exam in students' hardest course, we used a repeated measures ANOVA. There was not a statistically significant interaction between cluster membership and time, Wilks Lambda = .92, $F(3, 78) = 2.20$, $p = .09$, partial eta squared = .08, indicating that cluster membership did not differentially impact changes in exam grades over time (see Table 3.7 for summary of analyses and Table 9 for mean grades). There was not a significant main effect for time, Wilks Lambda = 1.00, $F(1, 78) = .22$, $p = .64$, partial eta squared = .003. The main effect comparing all clusters was significant, $F(3, 78) = 3.09$, $p = .03$, partial eta squared = .11. Simple effects analysis showed that of the four clusters, only Cluster 3 (High FM/ High EA/ Mod AA) experienced a statistically significant increase in grade from midterm ($M = 1.85$, $SE = .30$) to final exam ($M = 2.34$, $SE = .24$), but not enough to surpass any of its peers. Midterm exam grades only differed between Cluster 3 ($M = 1.85$, $SE = .30$) and Cluster 4 ($M = 3.20$, $SE = .37$). Final exam grades did not differ between clusters.

Univariate ANOVAs were used to explore the association between mid-quarter and post-quarter clusters and students' grades in their hardest course and their overall end-of-quarter GPA. See Table 3.8 for a summary of the analyses and Table 3.9 for mean grades and GPA for each

cluster at both time points. Results indicated that students' course-specific mindset and attribution patterns were not statistically significantly associated with the grade they received in their hardest course; (Mid-quarter: F (3, 128) = .32, p = .81, partial eta squared = .01; Post-quarter: F (3, 128) = .43, p = .74, partial eta squared = .01). Follow-up analysis were conducted to explore the extent to which students' cluster memberships at mid-quarter and post-quarter were related to students' end-of-quarter GPA or to their midterm/final exam grades. Using univariate ANCOVA techniques, results indicated that students' mindset and attribution beliefs were not statistically significantly associated with their end of quarter GPA (Mid-quarter: F (3, 129) = 1.14, p = .34, partial eta squared = .03; Post-quarter: F (3, 129) = .70, p = .55, partial eta squared = .02). Chi-square analyses revealed that patterns were not associated with students' midterm/final exam grades at each respective time point (Midterm: $\chi^2(30) = 28.10$, $p < .57$; Final Exam: $\chi^2(27) = 19.44$, $p < .85$).

Additionally, follow-up analyses were conducted to understand the extent to which students' perceptions of how well they felt they performed on their midterm exam was associated with their cluster membership. For example, students who endorse a growth mindset and felt they performed well on their midterms may be more likely attribute their successful performance to their abilities later on for subsequent exams. Pearson's Chi-square test revealed that at neither time point was cluster membership statistically associated with students' perceptions of their performance on the midterm or final exam, (Mid-quarter: $\chi^2(6) = 7.59$, $p = .27$; Post-quarter: $\chi^2(6) = 5.28$, $p < .51$), indicating that there was a mix of positive and negative perceptions on performance within each cluster. Taken together, these results indicate that even though students may have different types of combinations of mindsets and attributions, any one type of belief

pattern may not be more or less adaptive for students in terms of their perceptions of their performance or their actual performance in their hardest course.

Discussion

We explored the notion that attributing academic performance to both effort and natural ability or intelligence is an important component of the psychological benefits of having a growth mindset. Advocates of mindset theory have promoted effort-oriented thinking and behaviors, encouraging students to believe in their potential to expand their intelligence through hard work, studying and learning, while simultaneously cautioning that ability-focused thinking is detrimental to motivation and the learning process. In contrast, proponents of attribution theory and expectancy value theory suggest that attributing one's performance, and especially successful performance, to stable ability could facilitate academic motivation and engagement. In the present study, we took an intra-individual pattern-centered approach to explore the relationships among growth mindset, fixed mindset beliefs, and both effort and ability performance attributions in order to examine the associations of having a growth mindset with academic performance and motivation when combined with the dual power of their efforts and abilities, rather than effort alone. Findings from our study indicated that even though students have different types of combinations of mindsets-attribution beliefs, any one type of belief pattern may not be more or less adaptive for students in terms of their perceptions of their performance or their actual academic performance. This is not to say that these beliefs would not have an impact on long-term achievement, but that is yet to be determined.

We identified four quite similar growth/fixed mindset and effort/ability causal performance attribution patterns during two time points in an academic quarter, at mid-quarter and post-quarter. As predicted, a group of students strongly endorsed growth mindset beliefs and

effort attributions (Mid-quarter and Post-quarter Cluster 1: High GM/ High EA). Also as predicted, another group of students strongly endorsed a growth mindset and made strong effort and ability attributions (Mid-quarter Cluster 2: High GM/ Mod-High EA & AA; Post-quarter Cluster 2: High GM/ High EA & AA). A third group of students endorsed strong fixed mindsets and moderate to high effort and ability attributions (Mid-quarter Cluster 3: High FM/ Mod EA & AA; Post-quarter cluster 3: High FM/ High EA/ Mod AA) and also matched our predictions. A fourth cluster closely matched our predictions about finding a group of students who endorsed all beliefs to a moderate extent (Mid-quarter Cluster 4: Mod-High GM/ Mod FM/ Low-Mod EA & AA; Post-quarter Cluster 5: Mod FM & GM/ Mod EA/ Low-Mod AA). The only group to not emerge in our analyses as predicted was students who strongly endorsed a fixed mindset and only made strong ability attributions. Cluster linkage analysis indicated that most students were likely to maintain the same belief pattern group from mid-quarter to post-quarter, suggesting that mindset-attribution belief patterns are relatively stable across a one-month period of time. Significant linkages included students who maintained a strong growth mindset or strong fixed mindset over time (e.g., students who were in Cluster 1, 2, or 3 at mid-quarter were more likely to remain in the same cluster by post-quarter), indicating that when one type of mindset belief was much stronger than the other, students were more likely to maintain the strength of their mindsets and attributions. Students who maintained their growth mindsets were more likely to have higher utility value for their courses compared to students who shifted to stronger fixed mindset beliefs, and students who maintained their growth mindset beliefs were more likely to have higher attainment value compared with students who maintained more moderate mindset beliefs.

We also explored the extent to which academic performance indicators (course performance, GPA, and students' perceptions of their performance) and motivation-related beliefs between certain types of belief patterns were related (see Figure 3.6 for a summary of cluster differences for each dependent variable). We tested the following specific predictions: a) individuals who have strong growth mindset beliefs, strong fixed mindset beliefs, and balanced mindset beliefs, and b) individuals who endorse a growth mindset and only endorse effort performance attributions versus individuals who endorse a growth mindset and both effort and ability performance attributions. As predicted, findings suggested that students who endorsed a growth mindset (Cluster 1 and Cluster 2) had stronger synchronous motivation-related beliefs than students who endorsed a fixed mindset (Cluster 3) or balanced mindsets (Cluster 4), but this effect was nuanced by the type attributions endorsed as well. In support of our predictions, results indicated that across both time points, students who strongly endorsed a growth mindset coupled with strong effort and ability attributions had stronger subjective task value beliefs (attainment value, utility value, and intrinsic value) for their hardest course compared with students who had stronger fixed mindset beliefs coupled with moderate effort and ability attributions and students who had more moderate growth and fixed mindset views coupled with lower effort and ability attributions. We had expected, but did not find, any statistically significant differences between students in Cluster 1, who had a growth mindset and made only strong effort attributions and students in Cluster 2, who had a growth mindset and made both strong effort and ability attributions. Contrary to our predictions, there were no statistically significant differences in students' end-of-course grade, or overall GPA. We also investigated the extent to which endorsing effort causal performance attributions may protect students who have a fixed mindset from the suggested possible debilitating effects on academic performance and

motivation associated with fixed mindsets; however, given that only one group of students with strong fixed mindset beliefs appeared in our sample, we cannot make claims regarding the differential impact of attributions for students with this kind of thinking. In the following section, we further discuss our confirmed predictions, findings that did not support our hypotheses, unexpected and exploratory findings, limitations and future directions. We also discuss how our findings may add to the mixed findings regarding whether mindset beliefs are capable of changing over time.

Confirmed Predictions: Positive Associations of a Growth Mindset and Motivational Beliefs

As we predicted, having a growth mindset and endorsing ability attributions along with effort attributions was associated with stronger utility value, attainment value, intrinsic value, and self-concept of ability for student' hardest course compared to their peers who had stronger fixed mindsets or more moderate beliefs**.** Students who strongly endorsed a growth mindset alongside moderate to strong effort and ability performance attributions (Cluster 2-High GM/ High EA & AA) consistently had the highest course-related motivation beliefs, lending evidence to Harackiewicz and Elliot's (1995) position that may be beneficial for an individual to understand their innate talent to be one of the reasons why they are doing well in a subject. These types of students had the same levels of attainment value as their peers who also had a growth mindset but only strongly endorsed effort attributions (Cluster 1-High GM/High EA). In other words, both groups of students with strong growth mindsets, regardless of the strength of their ability attributions, rated that being good at the subject material in their hardest course was highly important for their identity. However, only students who also made strong ability attributions had attainment value that was statistically significantly greater than students who

strongly endorsed a fixed mindset and made moderate attributions (students who only made effort attributions coupled with their growth mindset did not). Students in Cluster 1- High GM/ High EA had about the same levels intrinsic value as their peers in Cluster 2- High GM/High EA & AA at mid-quarter. However, at post-quarter, students in Cluster 2 had statistically significantly stronger intrinsic value than students in Cluster 1. Students in Cluster 2 were also more likely than any other group of students to see the usefulness and relevance of the learned material in their course for later in life post-graduation or career-wise. They were also more likely to enjoy doing work for their hardest course than students who had stronger fixed mindsets and weaker effort and ability attributions.

Findings regarding both Cluster 1 and Cluster 2 are supported by mindset theory's predictions about students with a growth mindset; however, students who also endorsed ability attributions alongside their mindsets had more positive associations with motivation-related beliefs. Thus, our findings regarding Cluster 2 are theoretically supported by Weiner's attribution theory (Weiner, 1986), which posits that students who have greater expectancies for their success because they believe they are talented, attach greater value to their courses and have an increased likelihood of taking more challenging courses. Students develop higher subjective task values for their courses because their performance can be incorporated into their developing academic identity and the pleasure they can derive from feeling talented in that field, but also because they believe they have volitional control to change their outcomes. Our findings also support what Harackiewicz and Elliot (1995) suggested: if a student holds a growth mindset and only attributes their performance to effort attributions, they do not benefit from the positive feedback of their success because they would not believe their performance was due to their natural talent or intelligence. A student who views a course as difficult and thinks that the main reason of their

success is their own effort may reduce the value they attach to that subject domain because they may be less likely to conclude that they are truly talented at that subject, which is why we might see higher utility value and intrinsic value in Cluster 2 than other clusters. Given that the major difference between Cluster 1 and Cluster 2 was the level of endorsement of ability attributions, we suggest that making strong ability performance attributions, in conjunction with endorsing a growth mindset and making strong effort attributions, may be positively related to several indicators of subjective task value.

Unconfirmed Predictions: Lack of Support for Achievement Differences Between Mindset-Attribution Clusters

Contrary to what we expected, having a growth mindset was not associated with higher grades or overall GPA and having a fixed mindset was not associated with lower course performance or GPA. Given the suggestions by Dweck and colleagues that having a fixed mindset harms learning and achievement, it is surprising that students in our sample who strongly endorsed a fixed mindset (Cluster 3) did not have lower grades or GPAs than their peers, despite their lower attainment value and intrinsic value. However, it is possible that harboring moderate to strong fixed mindset beliefs over time may lead to declines in achievement over the course of their college years when courses become even more challenging or not. Regardless of whether these students enjoy their coursework or find it fulfilling, students in our sample were performing on par with their peers who have much stronger growth mindsets, even though they did not think they were doing as well. At mid-quarter, Cluster 3 had significantly lower self-concept of ability than Cluster 2 (High GM/ Mod-High EA & AA). If students with strong fixed mindsets do not feel they are performing as well as their peers feel they are performing in their courses, they may be less likely to pursue further challenging

courses or careers in these subject domains, which is intriguing because our study indicates that their achievement levels do not differ from their peers. Follow-up studies would be necessary to understand how fixed mindset thinking further impacts future course and career choices.

We did not see statistically significant differences in changes in exam grades over time. Mindset theory would suggest that students with a fixed mindset would experience declines in achievement over time, especially when the material is challenging, and although this was not the case in our sample, investigating grade trends over longer periods of time is needed to further understand the relationship between mindsets and changes in achievement over time. We used students' self-reported midterm and final exam grades, and although these grades were moderately correlated with students' perceptions of their performance on their exams, they were weakly correlated with end-of-course grades. This disconnect between the two measures of course performance may indicate a few things. First all, students' perceptions of their performance throughout the course may not accurately align with the actual grade they receive in the course because exam grades may not account for as much weight in their final grades when other assignments are also factored in. Another explanation may be that students are not fully aware of how their final grades will be calculated and may attribute lesser or greater weight to their exams. In the present study, we did not differentiate between whether or not the courses students selected as their hardest course were major requirements or elective courses, which may be essential in understanding why students' values could differ. Focusing on stable factors such as intelligence as the causes of performance may lead some people to become highly concerned with measuring and validating their intelligence, but whether or not this is harmful for students' learning may depend on what majors these students' have selected and whether these courses are necessary for the completion of their degree. Future studies should explore the extent to which

students' mindset-attribution beliefs and motivation-related beliefs about courses specific to their major differ from courses they are required to take by the university but are not related to their degree of interest.

Selected Unexpected and Exploratory Results

Some of our findings were not expected but interesting, nonetheless. These findings include the ways in which Cluster 1 (High GM/ High EA) differed from other clusters; results for students who had all moderate beliefs (Cluster 4); and differences in self-concept of ability across clusters. As predicted, students who had a strong growth mindset and made strong effort attributions (but did not make strong ability attributions), had higher levels of motivation-related beliefs compared with students who did not strongly endorse a growth mindset (Cluster 3 and Cluster 4); however, these group differences did not persist by the end of the quarter. Students who endorsed a growth mindset and only made strong effort attributions (Cluster 1) had higher levels of attainment value than students who endorsed moderate mindsets and attributions (Cluster 4); had higher levels of intrinsic value than students who had strong fixed mindsets and made moderate attributions (Cluster 3), but unexpectedly, only at mid-quarter. By post-quarter, the differences between these groups had disappeared. Contrastingly, students in Cluster 2 had significantly higher subjective task value at *both* time points. However, given that motivation beliefs were only measured during mid-quarter, future studies would need to see if subjective task value changed in different ways for these groups by the end of the quarter.

Predictions for students who held more moderate mindsets and attributions were largely exploratory and yielded some interesting findings. Students in Cluster 4 had nearly equivalent beliefs and performance as their peers with strong fixed mindsets (Cluster 3); had lower utility value, attainment value, and intrinsic value than students who had a growth mindset and made

effort and ability attributions; and did not statistically significantly differ in their utility value from students who had strong growth mindsets and only strong effort attributions. In past research, very little attention has been given to students who do not endorse one type of mindset more than another; however, the present study indicates these students may have distinctly different types of beliefs than their peers who lean more toward one mindset. These students moderately endorsed both a fixed mindset and growth mindset, which although initially appears contradictory, may actually indicate that these students are unsure of or ambivalent toward their beliefs about the malleability of their intelligence. As such, even though these students do not endorse a fixed mindset to the same extent as Cluster 3, the lack of strong agreement with mindset beliefs and attributions appears to be negatively associated with the values they attach to their coursework.

Given that the clusters in our sample primarily differed in their motivation-related beliefs and not their achievement, it was interesting to see that students in Cluster 2- High GM/ Mod-High EA & AA had significantly higher self-concept of ability than Cluster 3. This might indicate that regardless of actual grades received, the combination of a strong growth mindset and strong effort and ability attributions may be associated with stronger perceptions that one is good at a particular subject domain, even if it is not significantly associated with actual achievement. Perceptions that one is truly good in a course or subject domain are important because they help students make decisions about what courses to pursue, what majors to choose, and what majors to change. What information students use to determine whether or not they are good or able in their courses needs further exploration as these beliefs may differ between students. For instance, for some students getting a B might be deemed outstanding work and others might consider it an academic setback. Perceptions may further differ within-person

across subject domain; for instance, a student might think passing is good enough for their most difficult math course but believe only an A- or higher is acceptable for one of their elective courses.

Are Mindsets More State-like or Trait-like?

The present study provides another possible answer to the question of whether mindsets are more state-like or trait-like and may shed some light on whether mindsets are likely to change over time. Mindsets have been generally considered stable and trait-like beliefs that we ascribe to a host of areas in our life, including in relationships and parenting. Although Dweck has suggested that mindsets may change over time (Dweck, 2007, 2015), this has not been demonstrated empirically to a great extent (for exceptions, see Robins & Pals, 2002; Shively & Ryan, 2013; Yeager et al., 2016). For example, Shively and Ryan (2013) found that college students' growth mindset beliefs surrounding their intelligence in math became weaker over the course of a semester in college algebra. In the current study, we saw that most students maintained their beliefs from mid-quarter to post quarter. Most students who endorsed one type of mindset to a high level were more likely to maintain the strength of their beliefs, but some of these students shifted to more moderate views by the end of the quarter. Students who maintained their growth mindset beliefs saw greater relevance in their courses compared with students who shifted toward more fixed mindset beliefs, and students who maintained their growth mindset beliefs were more likely to believe the work in their hardest course was important for their identity compared with students who maintained moderate beliefs. These findings suggest that the shifts to more fixed or moderate views might be connected to negative course experiences, but future research needs to explore the negative association with subjective task value further.

Many students face new personal and academic challenges and are forced to learn how to cope with multiple demands on their time, energy, and emotions (Cantor et al., 1987). Thus, their beliefs about whether their intelligence is malleable or fixed may be more transient and state-like depending on their courses and the feedback they receive from their grades and professors. It could be possible that contextual factors such as the difficulty of a course, negative feedback, poor grades, and repeated failing may alter one's mindset. Future studies should explore why some students are more likely to alter their belief patterns and if this is related to their experiences in their courses. This may be effectively understood through qualitative interviews with students as they progress through an academic quarter. With some shifts in beliefs indicated during the approximately four to five weeks that passed between the two waves of data collection, perhaps macrolevel changes may occur over greater periods of time.

Limitations and Future Directions

Our study has several limitations, including limited size of and variability in the analysis sample, the ambiguity in ascertaining whether students were making attributions for their successes or failures, and a limited understanding of students' perceptions of their overall performance in their courses. Each limitation is discussed in the following section in further detail.

The particular characteristics of the present study's sample may have made it more challenging to see differences in academic achievement between students who had different types of mindsets and attribution patterns. The analysis sample was relatively high-achieving with an average GPA of 3.17; thus, differences in mindsets and attributions may be more pronounced in a sample with greater variability in achievement levels. Research has indicated that growth mindset interventions are particularly helpful for struggling students so perhaps

findings might differ for a sample that had more low-achieving students. Given that high-achieving students usually do not benefit from growth mindset initiatives for several reasons, including that they already have productive ways to handle academic challenges, it may not be surprising that even students who had strong fixed mindsets in our sample performed on par with their peers who had growth mindsets. It is possible that students who are already high-achieving may not face academic setbacks or struggles often, such that they are never forced to question their "fixed" amount of intelligence. Furthermore, when setbacks are faced, high-achieving students may already have effective plans for how to overcome their obstacles that have historically worked for them. Thus, the purported differences in academic performance suggested by mindset theory may be nullified between students who have a growth mindsets and fixed mindsets when they are high-achieving, but more readily apparent when students' achievement levels differ from each other. Thus, students' mindsets may be more closely related to students' achievement when students are low-achieving or constantly facing academic difficulties or setbacks.

The current sample also lacked variability in gender, so we were unable to look at how males and females differed in their beliefs. The sample was predominantly comprised of women, and females in general are more likely to have stronger growth mindsets than their male counterparts (Ablard, 2002; Dweck & Bush, 1976; Leondari & Gialamas, 2002), which may explain the high proportion of students who had growth mindsets. Future studies should attempt to replicate findings with a more gender-balanced sample to understand if males would experience the same impact on their course-related motivation.

Given the limited sample size of the study and the lack of variability in student majors, we may see differences in the associations of mindsets, attributions, and course achievement in

students who have other types of majors outside of the social sciences and liberal arts. In the early years of college, most students are taking pre-requisites and general education courses that may have little to do with the subject matter in their chosen major. Notably, the majority of students in this study were recruited from two non-major biology courses, and many students selected that course as their most difficult course of the quarter. Students' mindsets and attributions may function differently for course material they are less invested or less familiar with as compared to the courses regarding more major-specific material. Whether or not classes that students chose to take out of interest or passion have a greater impact on their mindsets or attributions is yet to be researched.

This study did not differentiate whether students were attributing an unsuccessful performance or successful performance to effort or ability attributions because preliminary analyses indicated that mindset beliefs and attribution beliefs did not differ between students who felt they performed poorly, fairly, or well on their midterm/final exam. In the current study, these performance perceptions were meant to be understood as a proxy for whether students felt their exam performance was a "success" or a "failure." Students within each cluster had a relative mix of perceptions regarding their performance, with no single type of cluster more likely to have students who had one type of perception over another. Because students did not differ in these perceptions across the mindset-attribution clusters, it was not deemed feasible or worthwhile to further separate the mindset and attribution patterns into success/failure groupings. However, attribution theory distinguishes that the impact of attributing one's performance to stable or unstable characteristics is dependent on whether students perceive the performance to be a success or a failure; as such, this may be a necessary step for future studies with larger sample sizes. The lack of differences in mindset and attribution beliefs may be because most

students in the sample felt they performed fairly or well on their exams, making it harder to see the differences experienced by students who felt they did poorly. Although students' performance perceptions did not significantly differ between cluster groups, perhaps in a different or larger sample, it would be easier to elucidate whether students who feel they are performing poorly in their course or especially well in their course are more likely to adjust their beliefs. The current study utilized a measure of students' perceptions of their performance on specific exams; however, future studies may use a broader indicator of students' overall perception of their performance in the course.

Mindset theory, attribution theory, and expectancy-value theory would all agree that attributing difficulties and failures to stable characteristics such as talent or intelligence may undermine motivation, but the perspectives diverge when considering academic successes; thus, future studies should attempt to distinguish the motivation-related impact of having a growth mindset and making effort and ability attributions for one's academic failures versus one's academic successes. One possible way to do this would be to include additional choices when students are asked to rate the importance of causal factors. The current study asked students to rate the importance of Talent, Intelligence, and Ability as well as Effort, Amount of Time Spent Studying, and How Hard You Worked in determining their performance on their course exams. Additional choices such as Lack of Talent, Lack of Intelligence, and Lack of Ability as well as Lack of Effort, Lack of Time Spent, and Not Working Hard Enough may allow for a clearer distinction of how students understand the reasons for their less than desirable course performance.

Concluding Remarks

Through an intra-individual approach, we were able to find evidence that suggested a dual attribution to both effort and talent may have more positive associations with course-related motivation than the effort-oriented thinking championed by mindset scholars. Believing that their intelligence was malleable and endorsing effort and ability causal performance attributions was almost always associated with higher endorsements of motivational beliefs compared with only making effort attributions alongside a growth mindset. These findings have implications for future mindset interventions that may benefit from adding an additional component that encourages students to believe in their intelligence alongside their effort-focused endeavors. Given that these mindset interventions hinge on the idea that students should believe that they can grow their intelligence and abilities through seeking more challenges, encouraging students to also believe in harnessing this intelligence may be easily incorporated into existing interventions.

References

Ablard, K. E. (2002). Achievement goals and implicit theories of intelligence among academically talented students. *Journal for the Education of the Gifted, 25*(3), 215–232. doi:10.1177/016235320202500302

Beasley, T. M., & Schumacker, R. E. (1995). Multiple regression approach to analyzing contingency tables: Post hoc and planned comparison procedures. *Journal of Experimental Education*, *64*(1), 79-93. doi:10.1080/00220973.1995.9943797

Bergman, L. R., Magnusson, D., & El-Khouri, B. M. (2003). *Studying individual development in an interindividual context: A person-oriented approach*. Mahwah, NJ: Lawrence Erlbaum Associates.

Burns, K. C., & Isbell, L. M. (2007). Promoting malleability is not one size fits all: Priming implicit theories of intelligence as a function of self-theories. *Self and Identity*, *6*(1), 51-63. doi: 10.1080/15298860600823864

Cantor, N., Norem, J. K., Niedenthal, P. M., Langston, C. A., & Brower, A. M. (1987). Life tasks and cognitive strategies in a life transition. *Journal of Personality and Social Psychology, 53*, 1178–1191.

De Castella, K., & Byrne, D. (2015). My intelligence may be more malleable than yours: The revised implicit theories of intelligence (self-theory) scale is a better predictor of achievement, motivation, and student disengagement. *European Journal of Psychology of Education*, *30*(3), 245–267.

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. New York, NY: Psychology Press.

Dweck, C. S. (2007). *Mindset: The new psychology of success*. New York, NY: Ballantine

Books.

Dweck, C. S. (2015). Growth mindset, revisited. *Education Week.* Retrieved from http://www.edweek.org/ew/articles/2015/09/23/carol-dweck-revisits-the-growth-mindset.html

Dweck, C. S., & Bush E.S. (1976). Sex differences in learned helplessness: I. Differential debilitation with peer and adult evaluators. *Child Development, 12*(2), 147-156.

Dweck, C. S., Chiu, C. & Hong, Y. (1995a). Implicit theories and their role in judgments and reactions: A world from two perspectives. *Psychological Inquiry*, *6*, 267-285. doi: 10.1207/s15327965pli0604_12

Dweck, C. S., & Leggett, E. L. (1988). A social cognitive approach to motivation and personality. *Psychological Review*, *95*(2), 256–273. doi:10.1037/0033-295X.95.2.256

Eccles, J. S. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives* (pp. 75–146). San Francisco, CA: Freeman

Eccles J. S. (1984). Sex differences in achievement patterns. In T. Sondregger & R. A. Dienstbier (Eds.), *Nebraska Symposium on Motivation, 1984: Psychology and gender* (Vol 40, pp. 97-132). Lincoln: University of Nebraska Press.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., et al. (1983). Expectancies, values and academic behaviors. In J. T. Spencer (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 75-146). San Francisco: W. H. Freeman.

Eccles, J., Adler, T., & Meece, J. L. (1984). Sex differences in achievement: A test of alternate theories. *Journal of Personality and Social Psychology, 46,* 26–43.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents'

achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin, 21,* 215–225. doi:10.1177/ 0146167295213003

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53,* 109-132.

Eccles, J. S., Wigfield, A., Flanagan, C., Miller, C., Reuman, D., & Yee, D. (1989). Self-concepts, domain values, and self-esteem: Relations and changes at early adolescence. *Journal of Personality, 57,* 283-310.

Eccles, J., Wigfield, A., Harold, R. D., & Blumenfeld, P. (1993). Age and gender differences in children's self- and task perceptions during elementary school. *Child Development, 64,* 830–847. doi:10.2307/ 1131221

Eccles, J. S., Wigfield, A., & Schiefele, U. (1998). Motivation to succeed. In: W. Damon (Series Ed.) & N. Eisenberg (Volume Ed.) *Handbook of child psychology* (5th ed., Vol. III, pp. 1017–1095). New York: Wiley.

Elig, T. W., & Frieze, I. H. (1979). Measuring causal attributions for success and failure. *Journal of Personality and Social Psychology, 37,* 621-634.

Harackiewicz, J. M., & Elliot, A. J. (1995). Life is a roller coaster when you view the world through entity glasses. *Psychological Inquiry, 6*(4), 298–301. doi:10.1207/s15327965pli0604

Harter S. (1990). Causes, correlates and the functional role of global self-worth: A life-span perspective. In J. Kolligan & R. Sternberg (Eds), *Perceptions of Competence and Incompetence Across the Life-Span* (pp. 67–98). New Haven, CT: Yale University Press.

Henderson, V. L., & Dweck, C. S. (1990). Achievement and motivation in adolescence: A new model and data. In S. Feldman & G. Elliott (Eds.) *At the threshold: The developing*

adolescent. Cambridge, MA: Harvard University Press.

Hong, Y., Chiu, C., Dweck, C. S., Lin, D. M., & Wan, W. (1999). Implicit theories, attributions, and coping: A meaning system approach. *Journal of Personality and Social Psychology*, *77*(3), 588-599. doi:10.1037/0022- 3514.77.3.588

Leondari, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived competence: Impact on students' achievement behavior. *Psychology in the Schools*, *39*(3), 279–291. doi:10.1002/pits.10035

McCutchen, K. L., Jones, M. H., Carbonneau, K. J., & Mueller, C. E. (2016). Mindset and standardized testing over time. *Learning and Individual Differences, 45*, 208–213. doi:10.1016/j.lindif.2015.11.027

Mueller, C.M., & Dweck, C.S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology, 75*, 33–52.

Plaks, J. E., & Stecher, K. (2007). Unexpected improvement, decline, and stasis: A prediction confidence perspective on achievement success and failure. *Journal of Personality and Social Psychology, 93*(4), 667–684.

Robins, R. W., & Pals, J. L. (2002). Implicit self-theories in the academic domain: Implications for goal orientation, attributions, affect, and self-esteem change. *Self and Identity*, *1*(4), 313–336.

Shively, R. L., & Ryan C.S. (2013). Longitudinal changes in college math students' implicit theories of intelligence. *Social Psychology of Education*, *16*, 241-256. DOI 10.1007/s11218-012-9208-0

Vargha, A., Torma, B., & Bergman, L. R. (2015). ROPstat: A general statistical package useful for conducting person-oriented analysis. *Journal for Person-Oriented Research*, *1*(1-2),

87–98. doi:10.17505/jpor.2015.09

Weiner, B. (1972). Achievement attribution and the educational process. *Review of Educational Research, 42*(2), 203–215. doi:10.2307/1170017

Weiner, B. (1974). *Achievement motivation and attribution theory.* Morristown, N.J.: General Learning Press.

Weiner, B. (1985). *Human motivation*. New York: Springer-Verlag.

Weiner, B. (1986). *An attributional theory of motivation and emotion*. New York: Springer-Verlag.

Weiner, B., & Kukla, A. (1970). An attributional analysis of achievement motivation. *Journal of Personality and Social Psychology,* 15, 1-20. doi: 10.1037/h0029211

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review, 12,* 265-310.

Wigfield, A., & Eccles, J. S. (2002). Children's motivation during the middle school years. In J. Aronson (Ed.), *Improving academic achievement: Contributions of social psychology.* San Diego, CA: Academic Press.

Wigfield, A., Eccles, J. S., Yoon, K. S., Harold, R. D., Arbreton, A. J. A., Feedman-Doan, C., & Blumenfeld, P. (1997). Change in children's competence beliefs and subjective task values across the elementary school years: A 3-year study. *Journal of Educational Psychology, 89*, 451–469. doi:10.1037/0022-0663.89.3.451

Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., . . . Dweck, C. S. (2016). Using design thinking to improve psychological interventions: The case of the growth mindset during the transition to high school. Journal of Educational Psychology, 108, 374-391. doi:10.1037/edu0000098

Table 3.1

Confirmatory Factor Analysis of Mindset and Attribution Scales: Standardized and Unstandardized Coefficients

Observed	Latent construct	β	*SE*	*B*	*SE*
Model 1: Wave 2 Mindsets and Attributions					
Item 1	Fixed mindset	.86	.03	1	--
Item 2	Fixed mindset	.93	.02	1.07	.08
Item 3	Fixed mindset	.83	.03	1.07	.09
Item 1	Growth mindset	.89	.02	1	--
Item 2	Growth mindset	.94	.01	1.04	.06
Item 3	Growth mindset	.95	.01	1.11	.06
Item 1	W2 Effort attributions	.85	.05	1	--
Item 2	W2 Effort attributions	.77	.05	1.01	.13
Item 3	W2 Effort attributions	.64	.06	.78	.12
Item 1	W2 Ability attributions	.67	.06	1	--
Item 2	W2 Ability attributions	.83	.05	1.24	.18
Item 3	W2 Ability attributions	.78	.05	1.05	.15
Model 2: Wave 3 Mindsets and Attributions					
Item 1	Fixed mindset	.88	.02	1	--
Item 2	Fixed mindset	.96	.01	1.05	.07
Item 3	Fixed mindset	.90	.02	1.03	.07
Item 1	Growth mindset	.93	.02	1	--
Item 2	Growth mindset	.96	.01	1.03	.05
Item 3	Growth mindset	.90	.02	.97	.05
Item 1	W3 Effort attributions	.81	.13	1	--
Item 2	W3 Effort attributions	.77	.12	.89	.28
Item 3	W3 Effort attributions	.18	.10	1.87	1.10
Item 1	W3 Ability attributions	.67	.06	1	--
Item 2	W3 Ability attributions	.83	.05	1.24	.17
Item 3	W3 Ability attributions	.78	.05	1.05	.15

Table 3.2

Descriptive Statistics and Correlations

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 Wave 2: Fixed Mindset in hardest	2.81	1.13	--	-.74**	.59**	-.55**	-.28**	-0.01	-0.17	0.09	-0.14	0.28**	-0.14	-.33**	-0.03	-0.08	-0.05	-0.01	-0.17	-0.07	-0.02
2 Wave 2: Growth Mindset in hardest	4.64	1.05		--	-.44**	.51**	.25**	0.02	0.16	-0.1	0.05	0.19*	0.11	.21*	0.09	0.04	-0.07	-0.04	0.06	-0.06	-0.02
3 Wave 3: Fixed Mindset in hardest	2.91	1.24			--	-.63**	-.25**	0.15	-.18*	.24**	-0.16	-.24**	-.31**	-.32**	0.04	-0.12	-.10	-0.08	-.18*	-0.15	-0.02
4 Wave 3: Growth Mindset in hardest	4.62	1.05				--	.36**	0.04	.27**	-0.07	0.05	.23**	.20*	.26**	0.15	0	0.01	-0.01	0.03	0.07	-0.06
5 Wave 2: Effort attributions	4.08	0.78					--	0.08	.42**	0.15	0.02	.39**	.19*	0.16	0.34**	-0.06	-.15	-0.07	-0.01	-0.16	0.06
6 Wave 2: Ability attributions	3.11	0.95						--	-0.04	.59**	0.07	.19*	.21*	0.06	0.19	0.06	0.08	-0.02	0.01	-0.08	0.02
7 Wave 3: Effort attributions	4.08	0.76							--	0.14	0.03	.30**	.17*	.23*	.25**	-.07	0.09	0.12	0.05	0.02	0.13
8 Wave 3: Ability attributions	3.1	0.86								--	0.01	.21*	.26**	.17*	.31**	-0.21	-.07	-.18*	-0.12	-0.11	-0.06
9 Wave 2: Self-concept of ability	2.78	0.69									--	.34**	.30**	.44**	-.21*	.69**	.49**	.48**	.63**	.38**	.34**
10 Wave 2: Attainment value	3.09	1.13										--	.55**	.45**	0.17	0.18	0.11	0.14	.18*	-0.01	.19*
11 Wave 2: Utility value	2.91	1.16											--	.48**	0.16	.21*	.22*	.18*	0.15	0.06	0.08
12 Wave 2: Intrinsic value	2.67	1.12												--	-0.15	.20*	0.07	0.16	.30**	0.07	0.02
13 Wave 2: Cost	3.4	0.83													--	-.17	-.08	-0.04	-.18*	-0.12	0.02
14 Midterm exam grade	2.65	1.28														--	.67**	.71**	.74**	.43**	.54**
15 Final exam grade	2.84	1.01															--	.73**	.48**	.68**	.58**
16 Course grade	3.06	1																--	.56**	.47**	.72**
17 Perceptions of midterm performance	2.21	0.8																	--	.39**	.38**
18 Perceptions of final exam performance	2.31	0.74																		--	.33**
19 End of quarter GPA	3.17	0.65																			--

Note. ** Correlation is significant at the .01 level (two-tailed). * Correlation is significant at the .05 level (two-tailed)

Table 3.3

Mindset Attribution Cluster Linkages Across an Academic Quarter

	Profile at End of Quarter				
Mindset Attribution Pattern	High GM/ High EA	High GM/ High EA & AA	High FM/ High EA/ Mod AA	Mod FM & GM/ Mod EA/ Low-Mod AA	**Total**
Profile at Beginning of Quarter					
High GM/ High EA	20 [a]	4	4	7	35
High GM/ Mod-High EA & AA	7	21 [a]	7	13	48
High FM/ Mod EA & AA	2	2	10 [a]	10	24
Mod-High GM/ Mod FM/ Low-Mod EA & AA	6	3	5	10	24
Total	35	30	26	40	131

Note. Read across, each cell represents the number of students who started off in the row's profile at mid-quarter and ended up in the column's profile at post-quarter. [a] Cells are statistically significantly overrepresented at the p = 0.0031 level, the adjusted p-value after a Bonferroni correction for *post hoc* cell-wise analysis. GM = Growth Mindset. FM = Fixed Mindset. EA= Effort Attributions. AA= Ability Attributions.

Table 3.4

Summary of Univariate Analyses of Covariance (ANCOVA): Associations of Mid-quarter and Post-quarter Cluster Membership with Mid-quarter Motivation-Related Beliefs

Dependent Variable	*SS*	*df*	*MS*	*F*	η^2_p
Self-concept of ability					
Mid-quarter	3.62	3	1.21	2.72*	.06
Post-quarter	2.03	3	.68	1.48	.03
Attainment value					
Mid-quarter	37.70	3	12.57	12.36***	.22
Post-quarter	18.09	3	6.03	5.39**	.11
Utility value					
Mid-quarter	16.34	3	5.45	4.29**	.09
Post-quarter	28.17	3	9.39	8.17***	.16
Intrinsic value					
Mid-quarter	13.96	3	4.65	4.02**	.09
Post-quarter	19.11	3	6.37	5.78**	.12
Cost					
Mid-quarter	4.96	3	1.65	2.59	.06
Post-quarter	4.42	3	1.47	2.17	.05

Note. Cluster group membership is the independent variable at two time points—mid-quarter and post-quarter. Each dependent variable was measured only at mid-quarter. *SS* = sum of squares. *MS* = mean square. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 3.5

Means and Pairwise Contrasts from Univariate ANCOVA for Motivation-Related Beliefs in Mid-quarter Clusters

	1	*2*	*3*	*4*
	High Growth Mindset/ High Effort Attributions	*High Growth Mindset/ Mod-High Effort Attributions & Ability Attributions*	*High Fixed Mindset/ Mod Effort Attributions & Ability Attributions*	*Mod-High Growth Mindset/ Mod Fixed Mindset/ Low-Mod Effort Attributions & Ability Attributions*
Dependent Variable	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*
Self-concept of ability	2.76 $^{a\,b}$ (.11)	2.94 ^{a} (.10)	2.48 ^{b} (.13)	2.71 $^{a\,b}$ (.13)
Attainment value	3.31 $^{a\,b}$ (.17)	3.58 ^{a} (.15)	2.64 $^{b\,c}$ (.20)	2.21 ^{c} (.20)
Utility value	2.99 $^{a\,b}$ (.19)	3.26 ^{b} (.16)	2.67 $^{a\,b}$ (.23)	2.31 ^{a} (.23)
Intrinsic value	2.83 ^{a} (.18)	2.93 ^{a} (.15)	2.08 (.22)	2.46 ^{a} (.22)
Cost	3.34 ^{a} (.14)	3.60 ^{a} (.12)	3.49 ^{a} (.16)	3.07 ^{a} (.16)

Note. Cluster group membership is the independent variable. Read across each row, mean values with the same superscript denote clusters that are not statistically significantly different at the $p < .05$ level based on a Bonferroni adjustment for multiple comparisons.
* p < .05, ** p < .01, *** p < .001

Table 3.6

Means and Pairwise Contrasts from Univariate ANCOVA for Mid-quarter Motivation-Related Beliefs in Post-quarter Clusters

	1	*2*	*3*	*4*
	High Growth Mindset/ High Effort Attributions	*High Growth Mindset/ High Effort Attributions & Ability Attributions*	*High Fixed Mindset/ High Effort Attributions/ Mod Ability Attributions*	*Mod Growth Mindset & Fixed Mindset/ Mod Effort Attributions/ Low-Mod Ability Attributions*
Dependent Variable	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*
Self-concept of ability	2.79 [a] (.11)	2.98 [a] (.12)	2.61 [a] (.13)	2.74 [a] (.11)
Attainment value	3.16 [a b] (.18)	3.74 [a] (.19)	2.79 [b] (.20)	2.84 [b] (.17)
Utility value	2.83 [a] (.18)	3.73 (.19)	2.46 [a] (.21)	2.71 [a] (.17)
Intrinsic value	2.81 [a b] (.18)	3.29 [a] (.19)	2.30 [b] (.20)	2.41 [b] (.17)
Cost	3.28 [a] (.14)	3.69 [a] (.15)	3.48 [a] (.16)	3.24 [a] (.13)

Note. Cluster group membership is the independent variable. Read across each row, mean values with the same superscript denote clusters that are not statistically significantly different at the $p < .05$ level based on a Bonferroni adjustment for multiple comparisons.
* p < .05, ** p < .01, *** p < .001

Table 3.7

Summary of Repeated Measures Analyses of Variance (ANOVA): The Effects of Cluster Membership on Change in Exam Grades from Midterm to Final

Effect of the DV	*SS*	*MS*	Wilks Lambda	*df*	*F*	η^2_p
Time	.11	.11	1.00	1	.22	.003
Cluster	20.59	6.86	--	3	3.09*	.11
Time*Cluster	3.27	1.09	.92	3	2.20	.08
Error	38.61	.50	--	78	--	--

Note. Cluster group membership is the independent variable. The dependent variable is measured at two time points, mid-quarter and post-quarter. A dashed line indicates the measure was not included for the analysis. *SS* = sum of squares. *MS* = mean square.
* $p < .05$, ** $p < .01$, *** $p < .001$

Table 3.8

Summary of Univariate Analyses of Covariance (ANCOVA): Associations of Mid-Quarter and Post-Quarter Cluster Membership with Course Grades and GPA

Dependent Variable	*SS*	*df*	*MS*	*F*	η^2_p
Course Grade					
Mid-quarter cluster	.98	3	.33	.32	.01
Post-quarter cluster	1.21	3	.41	.43	.01
End-of-quarter GPA					
Mid-quarter cluster	1.43	3	.48	1.14	.03
Post-quarter cluster	.89	3	.30	.70	.02

Note. Cluster group membership is the independent variable. *SS* = sum of squares. *MS* = mean square. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 3.9

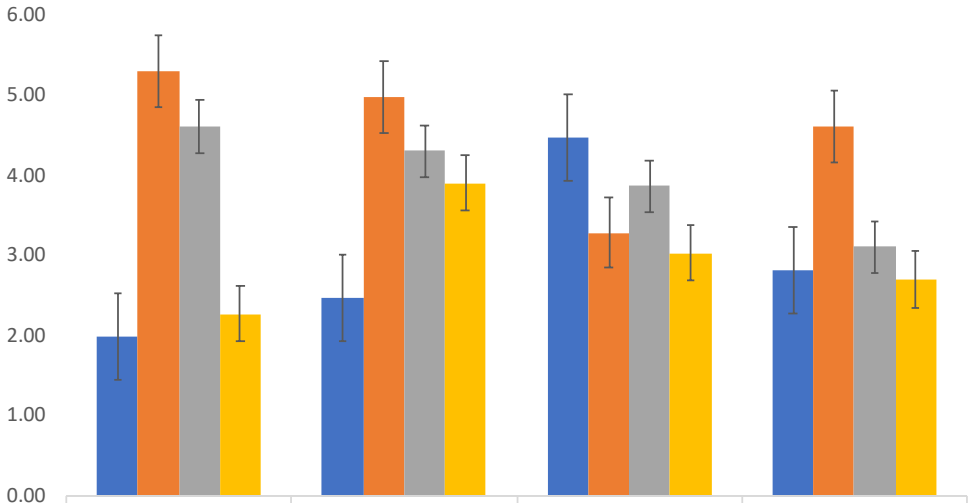
Means and Pairwise Contrasts from Univariate ANCOVA for Grades and GPA for Mid-quarter and Post-Quarter Clusters

	Cluster 1	*Cluster 2*	*Cluster 3*	*Cluster 4*
Dependent Variable	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*
Mid-quarter clusters				
Midterm Exam Grade	2.46 [a b] (.30)	2.85 [a b] (.22)	1.85 [b] (.30)	3.20 [a] (.37)
Course Grade	2.98 [a] (1.26)	3.13 [a] (.87)	2.93 [a] (1.01)	3.12 [a] (.86)
GPA	3.24 [a] (.63	3.23 [a] (.62)	3.14 [a] (.64)	2.97 [a] (.73)
Post-quarter clusters				
Final Exam Grade	2.43 [a] (.24)	3.02 [a] (.18)	2.34 [a] (.24)	2.78 [a] (.30)
Course Grade	3.22 [a] (.86)	3.06 [a] (1.12)	3.10 [a] (.81)	2.97 [a] (1.06)
GPA	3.19 [a] (.62)	3.18 [a] (.71)	3.31 [a] (.49)	3.08 [a] (.70)

Note. Cluster group membership is the independent variable. Numbers correspond to the clusters at each time point as described in the text. Read across each row, mean values with the same superscript denote clusters that are not statistically significantly different at the $p < .05$ level based on a Bonferroni adjustment for multiple comparisons.
* p < .05, ** p < .01, *** p < .001

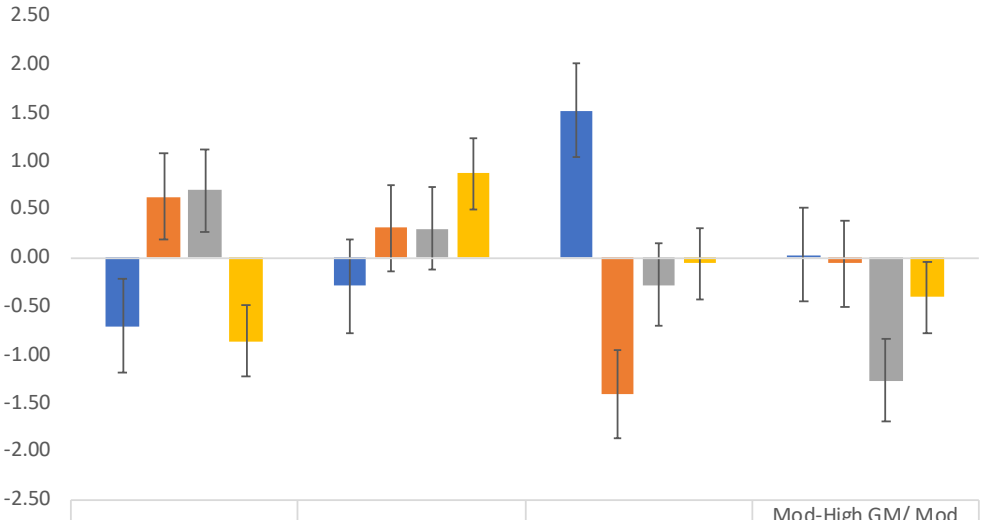
	Mid-Quarter (Wave 2)	Post-Quarter (Wave 3)
Mindset Measures		
Hardest course growth mindset	✓	✓
Hardest course fixed mindset	✓	✓
Attribution Measures		
Hardest course effort causal attributions for midterm/final exam	✓	✓
Hardest course ability attributions for midterm/final exam	✓	✓
Motivation-related Beliefs for Hardest Course		
Self-concept of ability	✓	
Attainment value	✓	
Utility value	✓	
Intrinsic value	✓	
Cost	✓	
Academic Performance		
Midterm/final exam grade	✓	✓
Course grade		✓
Perceptions of midterm/final exam performance	✓	✓
End of quarter GPA		✓

Figure 3.1. Summary of Chapter 3 Measures



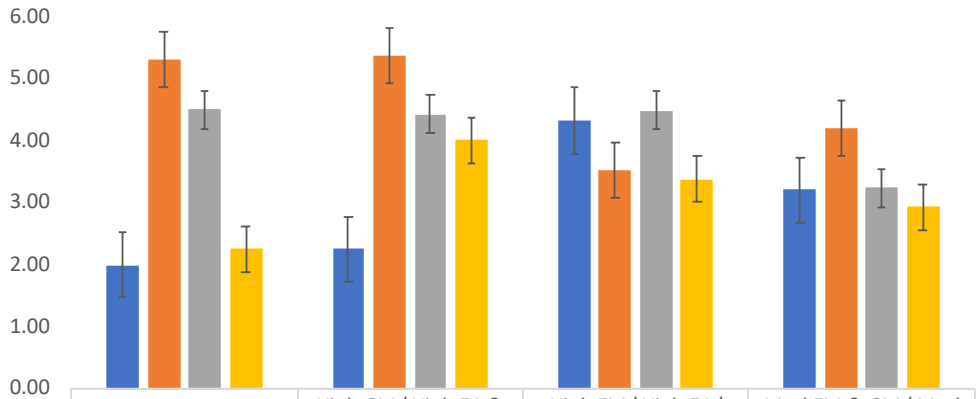
	High GM/ High EA	High GM/ Mod-High EA & AA	High FM/ Mod EA & AA	Mod-High GM/ Mod FM/ Low-Mod EA & AA
Fixed Mindset (FM)	2.00	2.47	4.49	2.83
Growth Mindset (GM)	5.32	4.99	3.29	4.63
Effort Attributions (EA)	4.62	4.31	3.87	3.12
Ability Attributions (AA)	2.28	3.92	3.04	2.71

Figure 3.2. Optimal Ward's method 4-cluster solutions for mid-quarter mindset and attributions (Unstandardized). Unstandardized means of fixed mindset, growth mindset, effort attributions, and ability attributions displayed for each cluster. Cluster names correspond to the profiles as described in the text.



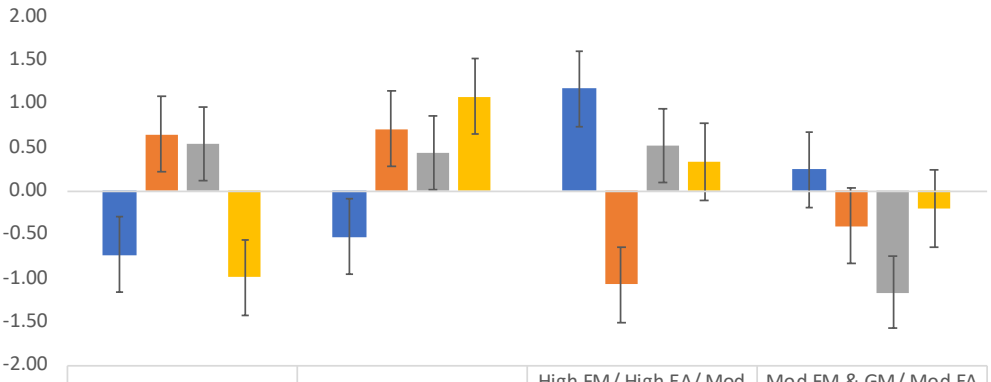
	High GM/ High EA	High GM/ Mod-High EA & AA	High FM/ Mod EA & AA	Mod-High GM/ Mod FM/ Low-Mod EA & AA
Fixed Mindset (FM)	-0.71	-0.29	1.52	0.03
Growth Mindset (GM)	0.63	0.31	-1.41	-0.06
Effort Attributions (EA)	0.70	0.30	-0.28	-1.27
Ability Attributions (AA)	-0.86	0.87	-0.06	-0.41

Figure 3.3. Optimal Ward's method 4-cluster solution for mid-quarter mindset and attributions (Standardized). Standardized means of fixed mindset, growth mindset, effort attributions, and ability attributions displayed for each cluster. The horizontal axis corresponds to the sample average. Cluster names correspond to the profiles as described in the text.



	High GM/ High EA	High GM/ High EA & AA	High FM/ High EA/ Mod AA	Mod FM & GM/ Mod EA / Low-Mod AA
Fixed Mindset (FM)	2.00	2.26	4.33	3.21
Growth Mindset (GM)	5.31	5.37	3.52	4.22
Effort Attributions (EA)	4.51	4.43	4.49	3.25
Ability Attributions (AA)	2.26	4.02	3.38	2.93

Figure 3.4. Optimal Ward's method 4-cluster solutions for post-quarter mindset and attributions (Unstandardized). Unstandardized means of fixed mindset, growth mindset, effort attributions, and ability attributions displayed for each cluster. Cluster names correspond to the profiles as described in the text.



	High GM/ High EA	High GM/ High EA & AA	High FM/ High EA/ Mod AA	Mod FM & GM/ Mod EA / Low-Mod AA
Fixed Mindset (FM)	-0.73	-0.52	1.17	0.25
Growth Mindset (GM)	0.65	0.71	-1.07	-0.40
Effort Attributions (EA)	0.54	0.44	0.52	-1.16
Ability Attributions (AA)	-0.99	1.08	0.33	-0.20

Figure 3.5. Optimal Ward's method 4-cluster solution for post-quarter mindset and attributions (Standardized). Standardized means of fixed mindset, growth mindset, effort attributions, and ability attributions displayed for each cluster. The horizontal axis corresponds to the sample average. Cluster names correspond to the profiles as described in the text.

Dependent Variables	Significant Group Comparisons	
	Mid-quarter	Post-quarter
Self-concept of ability	Cluster 2 > Cluster 3	--
Attainment value	Cluster 1 & 2 > Cluster 4 Cluster 2 > Cluster 3	Cluster 2 > Cluster 3 & 4
Utility value	Cluster 2 > Cluster 4	Cluster 2 > all other clusters
Intrinsic value	Cluster 1 & 2 > Cluster 3	Cluster 2 > Cluster 3 & 4
Cost	--	--
Midterm exam grades	--	--
Final exam grades	--	--
Course grades	--	--
Perceptions of midterm performance	--	--
Perceptions of final exam performance	--	--
End of quarter GPA	--	--

Figure 3.6. Summary of statistically significant group differences across several dependent variables. Dashed line indicates that there were no statistically significant differences between clusters for the dependent variable. Cluster numbers correspond to the following mid-quarter cluster names: Cluster 1: *High Growth Mindset/ High Effort Attributions;* Cluster 2*: High Growth Mindset/ Mod-High Effort Attributions & Ability Attribution;* Cluster 3*: High Fixed Mindset/ Mod Effort Attributions & Ability Attributions;* Cluster 4*: Mod-High Growth Mindset/ Mod Fixed Mindset/ Low-Mod Effort Attributions & Ability Attributions.*
Post-quarter cluster names: Cluster 1: *High Growth Mindset/ High Effort Attributions*; Cluster 2: *High Growth Mindset/ High Effort Attributions & Ability Attributions*; Cluster 3: *High Fixed Mindset/ High Effort Attributions/ Mod Ability Attributions;* Cluster 4: *Mod Growth Mindset & Fixed Mindset/ Mod Effort Attributions/ Low-Mod Ability Attributions.*

Appendix 3.1

Motivation-Related Belief Scale Items and Reliabilities

Self-Concept of Ability: α = .79

1. How good are you at the subject matter in your hardest course? (1 = not at all good to 5 = outstandingly good)
2. Compared to most of your other classes, how good are you at your hardest course? (1 = much worse to 5 = much better)
3. Compared to other people in your classes, how good are you at your hardest course? (1 = much worse to 5 = much better)
4. This quarter, how well do you think you will do in your hardest course? (1 = not well at all to 5 = outstandingly well)

Attainment Value: α = .87

1. Being good at the subject material in my most difficult course is an important part of who I am. (1 = not at all true for me to 5 = very true for me)
2. Compared to most of your other courses, how important is it for you to be good at your hardest course? (1 = not at all important to 5 = very important)
3. It is important for me to be someone who is good at the subject matter in my hardest course. (1 = not at all true for me to 5 = very true for me)

Utility Value: α = .90

1. The concepts I learn in my hardest course are valuable because they will help me in the future. (1 = not at all true for me to 5 = very true for me)
2. The subject material in my hardest course will be useful for me later in life. (1 = not at all true for me to 5 = very true for me)
3. Being good at the subject material in my hardest course will be important when I get a job or go to graduate school. (1 = not at all true for me to 5 = very true for me)
4. How useful is learning the subject matter in your hardest course for what you want to do after you graduate and go to work or graduate school? (1 = not at all useful to 5 = very useful)

Intrinsic Value: α = .94

1. I enjoy the subject matter in my hardest course. (1 = not at all true for me to 5 = very true for me)
2. I enjoy doing work for my hardest course. (1 = not at all true for me to 5 = very true for me)
3. How much do you like doing work for your hardest course? (1 = not at all to 5 = very much)
4. In general, I find working on assignments for my hardest course…(1 = not at all to 5 = outstandingly interesting)

Cost: α = .77

1. How much of your energy does it use up to do work for your hardest course? (1 = none to 5 = a great deal)
2. How much time do you have to spend to do well in your hardest course? (1 = none to 5 = a great deal)
3. I have to give up a lot to do well in my hardest course. (1 = not at all true for me to 5 = very true for me)
4. Success in my hardest course requires that I give up other activities I enjoy. (1 = not at all true for me to 5 = very true for me)

Appendix 3.2

Confirmatory Factor Analysis of Mid-quarter Motivation-Related Beliefs for Hardest Course

Observed	Latent construct	β	*SE*	*B*	*SE*
Model 1: Wave 2 Mindsets and Attributions					
Item 1	Self-Concept of Ability	.73	.05	1	--
Item 2	Self-Concept of Ability	.61	.06	.93	.14
Item 3	Self-Concept of Ability	.63	.06	.85	.13
Item 4	Self-Concept of Ability	.75	.05	1.07	.14
Item 1	Attainment Value	.81	.04	1	--
Item 2	Attainment Value	.80	.04	.91	.09
Item 3	Attainment Value	.83	.04	.96	.09
Item 1	Utility Value	.86	.03	1	
Item 2	Utility Value	.84	.04	.99	.08
Item 3	Utility Value	.80	.04	1.00	.10
Item 4	Utility Value	.84	.04	1.01	.09
Item 1	Intrinsic Value	.83	.03	1	--
Item 2	Intrinsic Value	.95	.01	1.20	.08
Item 3	Intrinsic Value	.92	.02	1.10	.08
Item 4	Intrinsic Value	.84	.03	.80	.07
Item 1	Cost	.59	.07	1	--
Item 2	Cost	.57	.07	.94	.17
Item 3	Cost	.75	.05	1.69	.31
Item 4	Cost	.81	.05	1.98	.35

Note. Confirmatory factor analysis verified the factor structure of the motivation-related beliefs of students at mid-quarter using structural equation modeling software in Stata 22 and relying on several statistical tests to determine the adequacy of the model fit to the data (e.g., chi-square test, comparative fit index, and RMSEA). Less than one percent of data was missing on one of the attainment value items and no data was missing for any other item; thus, thus, maximum likelihood with missing values was used for the estimation and all 135 participants were included in the model. Model fit indicators were as follows: χ^2 (152, n = 135) = 370.35, $p < .001$, the comparative fit index (CFI) = .92, the Tucker-Lewis fit index (TLI) = .91, and the RMSEA = .08. The five-factor model was a considerable improvement from the baseline model, χ^2 (171, n = 135) = 1695.71, $p < .001$.

Appendix Table 3.1

Summary of Univariate Analyses of Covariance (ANCOVA): Associations of Cluster Pattern Transitions with Additional Motivation-Related Beliefs and Academic Performance Indicators

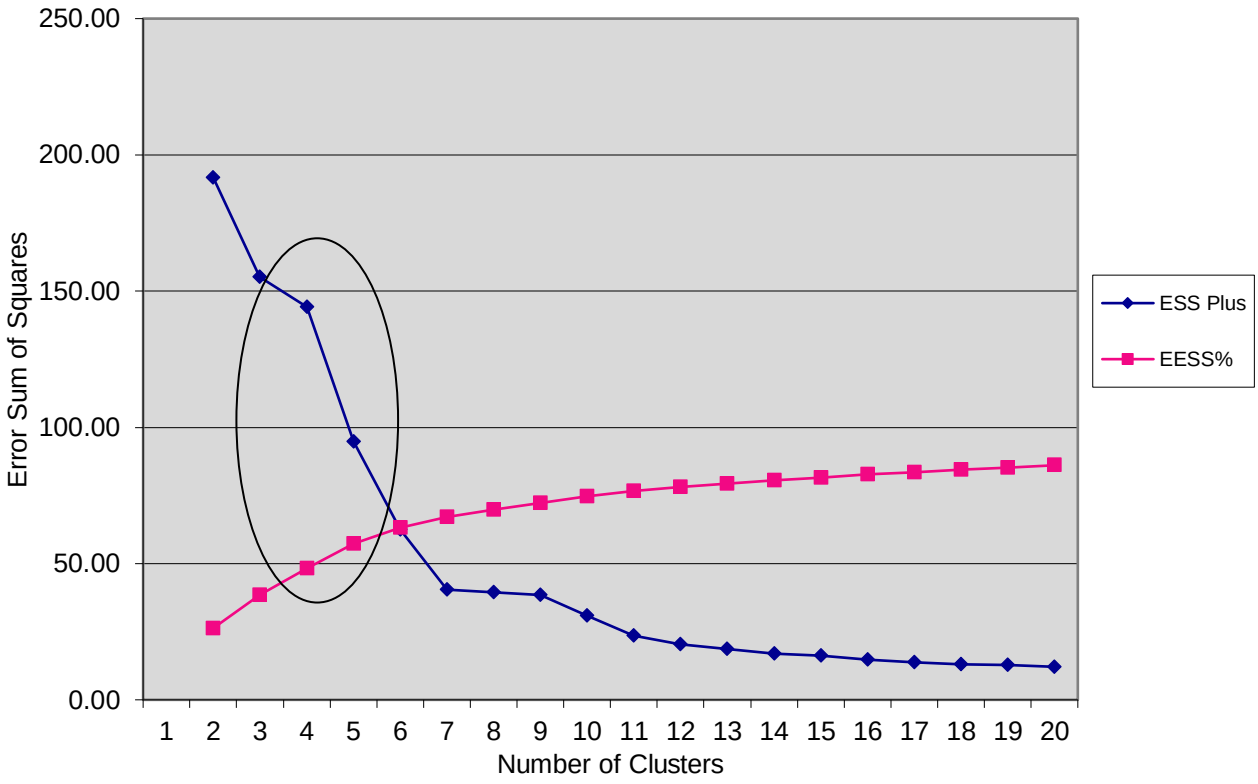
Dependent Variable	*SS*	*df*	*MS*	*F*	η^2_p
Self-concept of ability	3.32	5	.67	1.49	.06
Attainment value	29.30	5	5.86	5.60***	.18
Utility value	28.81	5	5.76	4.92***	.16
Intrinsic value	16.97	5	3.40	3.01*	.11
Cost	4.03	5	.81	1.21	.05
Midterm exam grade	11.37	5	2.27	1.45	.07
Final exam grade	2.48	5	.50	.51	.03
Course grade	2.11	5	.42	.44	.02

Appendix Figure 3.1

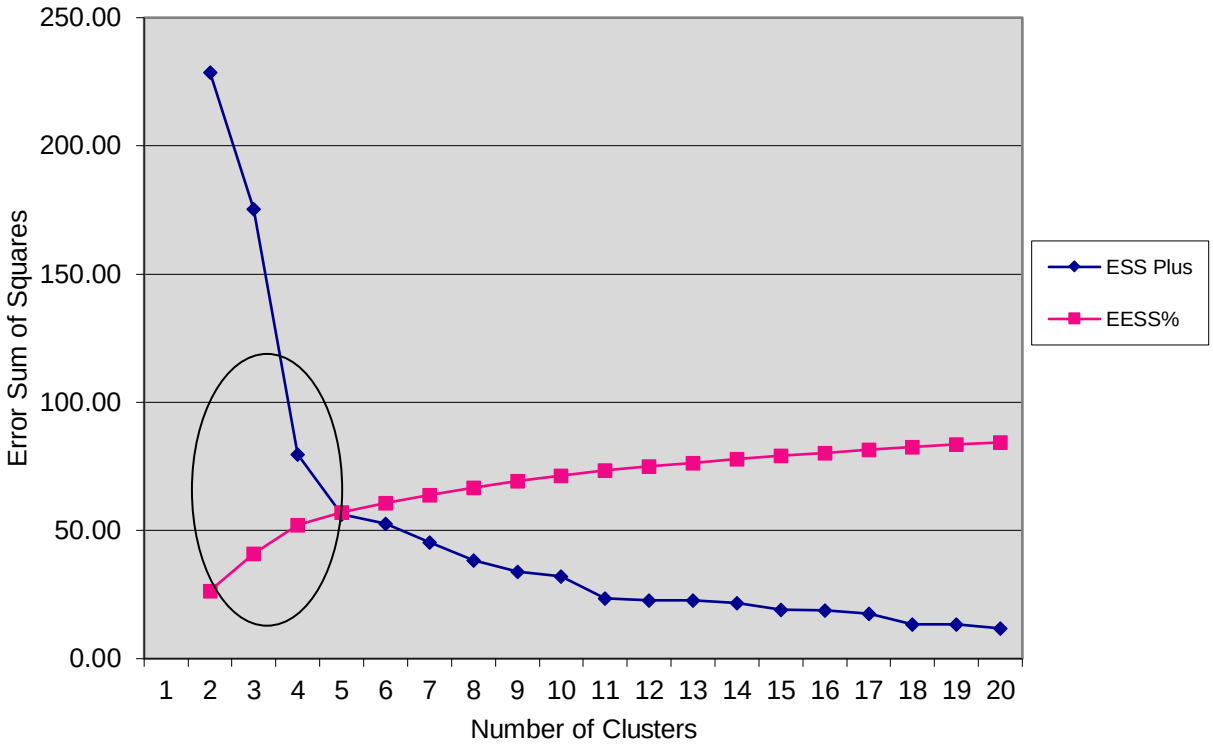
ESS Scree-type Plots Depicting Optimal Cluster Solutions

Two figures depict ESS Scree-type plots, illustrating an increase in error sum of squares (INC ESS) and explained error sum of squares (EXP ESS) by the number of cluster solutions. The oval illustrates the elbow in the plot that determined the optimal final solution for each type of pattern across two waves. Two cluster analyses were performed; thus, two plots were used to determine the optimal solution.

1. Wave 2 Mindset and Attribution Cluster Solutions



2. Wave 3 Mindset and Attribution Cluster Solutions



Chapter 4: Key Findings and Implications

Studies have shown that students' academic mindsets play a critical role in educational achievement and some have suggested that targeting these mindsets at the policy level may be an effective way to close the persistent achievement gaps in the United States (Rattan, Good, & Dweck, 2012). Growth mindset training has improved grades in middle school students, enhanced student persistence in online math games (O'Rourke, Haimovitz, Ballweber, Dweck, & Popovic, 2014), improved college students' year-end GPAs (Aronson, Fried, & Good., 2002), and improved high school students' GPAs in large-scale online interventions (Paunesku et al., 2015; Yeager et al., 2016). Interventions derived from both mindset theory and attribution theory have shown the power of getting students to focus on effort-based attributions for academic difficulties in facilitating the motivation to keep trying even when experiencing academic difficulties. The three studies in this dissertation attempted to fill theoretical and methodological gaps in contemporary mindset research. Mindsets have typically been understood as two separate worldviews, but findings indicate that there is a group of people who seem to endorse both views to the same extent. Previous studies have seldom discussed the implications of such a mindset. Our studies utilized both a general and course-specific measure of mindsets to understand if contextualizing mindsets resulted in different levels of beliefs or changes over the quarter, ultimately finding that students appear to have quite similar beliefs regarding their general and domain-specific intelligence. We attempted to shed more light on the question of whether mindsets behave in a more state-like or trait-like way, with our results suggesting that mindsets are probably more trait-like because they remained relatively stable over the course of an academic quarter.

Some of our hypothesized relationships between mindsets and academic performance indicators or performance causal attributions could not be confirmed, leading us to consider that characteristics of our high-achieving sample may make it difficult to see these types of associations. We also discuss how our pattern-centered approach illuminated an important finding that mindsets may be a part of a larger network of beliefs, that includes causal attributions, that students use to feel motivated and interested in their courses. Given that we did not find negative associations between having a fixed mindset and course achievement, we discuss possible reasons why having a fixed mindset may not be harmful for all types of students all of the time. In the following chapter, we examine the implications of our findings for continued research and interventions utilizing mindset theory.

Evidence Suggesting Mixtures of Mindsets

Recently, Dweck has suggested that it is possible for people to hold multiple types of mindsets (Dweck, 2015), but research has seldom explored this possibility. In Chapter 1 and Chapter 3, we utilized a pattern-centered approach to explore the individual differences in students' growth mindset and fixed mindset beliefs. Notably, we found one group of students who strongly endorse growth mindsets and weakly endorse fixed mindsets, one group of students who strongly endorse fixed mindsets and weakly endorse growth mindsets, and one group of students who endorse both mindsets to the same extent. In past research, very little attention has been given to students who do not endorse one type of mindset more than another. The present studies indicate that students who have moderate mindset views may have distinctly different types of beliefs than their peers who have stronger growth mindsets. Given that the items used to measure a growth mindset and fixed mindset could be interpreted as opposing beliefs, having moderate views of both a fixed mindset and growth mindset might indicate that students are

simply unsure of the malleability of their intelligence. Indeed, when students' beliefs were less extreme, they were more likely to change their beliefs over the course of the quarter. One possible explanation is that the specific course experiences these students have serve to shape their beliefs. As such, their beliefs may be more malleable to change. Recent studies have found that growth mindset interventions have their greatest impact on students who are struggling or are academically at risk; moreover, our findings may suggest that the students who are most susceptible to a change in their beliefs may be students who have less extreme beliefs to begin with. However, our findings did not indicate that students who had more moderate beliefs had lower achievement than their peers—but they did have lower subjective task value than students with strong growth mindsets. Students who had moderate growth mindset and fixed mindset views also tended to make moderate effort and ability performance causal attributions, indicating that they did not give greater importance to their effort over their abilities when understanding the causes of their performance. Given that this was consistently one of the largest groups of students, future research should look into how having a more moderate understanding of one's intelligence plays out for course choices and academic motivation over the subsequent years in college. As more interventions move forward, it is imperative to understand which students will be most impacted by the interventions that are being implemented in schools around the nation. Some students may be more open to adjusting their beliefs if they already have moderate views to begin with, but other students with stronger fixed mindset beliefs may need additional supports.

General and Domain-Specific Mindsets were Similar and Stable

Students' mindsets have typically been assessed as general constructs, and only a few studies have looked at how mindset regarding the malleability of intelligence differs across

domains (see Burns & Isbell, 2007; McCutchen, Jones, Carbonneau, & Mueller, 2016). That is, students are asked to think about their intelligence in general, rather than their intelligence in specific domains. One criticism of mindset theory suggests that beliefs about the malleability of intelligence are abstract concepts that are too removed from students' academic settings. Because students may think about their intelligence in one course differently than they think about it in another course, we used contextualized measures of mindset scales, asking students about their mindsets in their self-reported hardest and easiest courses. Chapter 1 explored how general mindsets, hardest course mindsets, and easiest course mindsets varied and developed in different ways, finding that all three of these constructs appeared to be quite similar overall and over the course of an academic quarter. In support of what Shively and Ryan (2013) found, the three types of mindset beliefs were also correlated with each other. Results indicated individual stability, for both general and course-specific mindsets, indicating that the way students endorse their growth mindset and fixed mindset beliefs may not be likely to change much over the quarter. Supported by findings by Robins and Pals (2002), some subtle changes in mindset patterns indicated that students who had moderate to strong growth mindsets were especially likely to maintain their beliefs over time. Students who had a strong fixed mindset at the beginning of the quarter tended to slightly weaken their beliefs over time. This finding was supported by both the variable and pattern-centered approaches. One possible explanation for why students' fixed mindset beliefs may undergo a slight shift is that they may be more apprehensive about the malleability of their intelligence at the beginning of a course, causing them to think there is nothing they can do to increase their intelligence. Students may be less optimistic without knowing what is in store for them throughout the course of the quarter and may believe that their intelligence may not grow or develop. By the end of the quarter, students

may be more convinced that their intelligence was in fact capable of growing or changing. Patterns were also consistent across general and both types of course-specific mindsets, indicating structural stability. Although Shively and Ryan (2013) found that domain-specific and general mindsets were coordinated in different ways and changed in different ways over time, our findings did not support this. However, given that there was considerable variability in the courses that students self-reported, it is difficult to ascertain whether assessing only biology intelligence mindsets or calculus intelligence mindsets would yield similar results. Past studies have assessed mindsets over significantly longer periods of time and in the present studies we only looked at changes across several weeks, further explaining why we may not have seen greater change in beliefs. Furthermore, we explored how different types of mindsets developed over time, without looking at how these three types of mindsets interact with each other; thus, we do not know whether students who endorse general growth mindsets are more likely to also endorse course-specific growth mindsets.

Mindsets Appeared to be More Trait-Like than State-Like

Dweck (2007, 2015) suggested that mindsets themselves may be malleable, even though they have typically been understood as stable trait-like characteristics. The studies in this dissertation aimed to shed more light on this question that has received little empirical attention. Our results indicate that mindsets may indeed be more trait-like. The mindset beliefs that students start off with are not likely to be altered on their own, especially when they are very strong, in either direction. Robins and Pals (2002) conjectured that the college achievement context may serve as a reactive person-environment interaction in which individuals react differently to the same environment depending on their traits, beliefs, and goals, such that the academic context simply reinforces individuals' beliefs about their intelligence and abilities.

Thus, they found that the college environment produced no mean-level change mindsets and that mindsets were relatively stable over time—a finding that was mirrored in our sample as well. Students may have been more likely to maintain their beliefs because the academic context reinforced what they already thought about their intelligence. However, an academic quarter may be too short of a time to see macrolevel changes that may occur over several years. For instance, students' mindsets may be markedly different when they graduate from college compared with when they first start college. Our results suggest this might be particularly true for students who have less extreme beliefs about the malleability of their intelligence. Our findings gave some indication that students who have more moderate mindset views were the most likely to shift toward more fixed mindset beliefs as opposed to stronger growth mindset beliefs. For students with moderate views, mindsets may be a state of mind and shift more as their perceptions of their performance take form and develop.

Mindsets Were Associated with Motivation, but not Academic Performance

Mindset interventions have been championed as a way to close the achievement gap; however, many recent studies have failed to replicate the findings that suggest these interventions raise achievement scores. Our studies attempted to understand how patterns of mindset beliefs were associated with students' achievement indicators. According to mindset theory, students with a growth mindset should be achieving at levels greater than their peers with a fixed mindset; however, our findings did not support this claim. There was no relationship found between any of the academic indicators (i.e., course grades, exam grades, and GPA) and mindsets. Particular characteristics in our sample may have made it more challenging to see differences in academic achievement between students who had different types of mindset and attribution patterns because our analysis sample was relatively high-achieving. Similarly,

mindset intervention studies have found that the interventions have little to no impact on high-achieving students, indicating that perhaps high-achieving students already had a growth mindset to begin with or already engage in constructive behaviors when they face challenges or setbacks. Furthermore, the coping strategies used by high-achieving students who have a fixed mindset may be working just fine for them whenever they do face challenges. High-achieving students may be less likely to repeatedly face challenges that cause them to question their intelligence. Thus, the purported differences in academic performance suggested by mindset theory may be nullified between students who have a growth mindsets and fixed mindsets when they are high-achieving, but more readily apparent when students' achievement levels differ from each other. Students' mindsets may be more closely related to students' achievement when students are low-achieving or constantly facing academic difficulties or setbacks. For this reason, the interventions have largely been targeted to helping academically at-risk or struggling students. In our sample, there were some students who indicated that they felt they did poor on their exams; however, they were not more or less likely to endorse a particular type of mindset either. Our sample was most likely not representative of that population of students, and findings may differ with a group of students who had more achievement level variability.

Another possibility may be that mindset beliefs are not quite as closely linked to achievement indicators as previously thought. As a way to shed light on what other types of beliefs mindsets may be associated with, Chapter 2 and Chapter 3 explored the relationship between mindsets and effort and ability performance causal attributions. If students have a growth mindset, they may be more likely to believe that their performance and achievement is determined by the amount of time they study or how hard they work compared with someone who has a fixed mindset. However, our findings were not able to confirm the hypothesized

relationships. It appeared that having a growth mindset was not related to making more effort attributions, which was surprising given that the growth mindset interventions have been used to promote more effort-oriented thinking and behaviors. Furthermore, mindsets were even less related to the types of ability attributions students made, indicating a lack of relationship between how students think about the malleability of their intelligence and whether they attribute their performance in their courses to their intelligence, talent, or abilities. These results were especially intriguing given that we were exploring the relationship between course-specific mindsets and course-specific attributions. Mindset beliefs have typically been thought of as broad and abstract concepts that students use to influence their academic behaviors, which then influences their academic motivation and achievement; however, findings from this study further indicate that more attention needs to be placed on what behaviors and choices mindset beliefs actually impact. The beliefs that cause someone to endorse a particular mindset most likely influence other types of beliefs and behaviors, because a mindset is not enough to produce increases in achievement alone. Results from Chapter 2 indicated that having a growth mindset did not actually make students believe to a greater extent that their efforts are a strong indicator of their performance, which leads us to wonder if having a growth mindset would lead to more effort-oriented behaviors for these students. Further research is needed to understand how having a particular mindset influences subsequent academic choices and behaviors. The present study assessed students' baseline beliefs without any type of intervention, indicating that many students already have a growth mindset. Perhaps the interventions teach students how to engage in more effort-oriented behavior and adopt more effort-oriented thinking, which may be one reason why we do not see a strong association between mindsets and attributions. Students may feel comfortable agreeing with ideas regarding the malleability of their intelligence when they

think about it under abstract or even hypothetical conditions but may need additional supports to apply their beliefs in helpful ways to their academic and learning behaviors.

Some Patterns of Mindsets and Attributions Were Associated with Stronger Motivation

Although we did not find support for the hypothesized relationships between mindset beliefs and achievement outcomes or causal attributions, our findings highlighted that certain types of combinations of mindsets and attribution patterns were associated with higher motivation-related beliefs, specifically subjective task value and self-concept of ability. No studies have yet to take a pattern-centered approach to understand the connection between mindsets and attributions, and if we had only interpreted our data using the variable centered approach in Chapter 2, we may have missed a key finding: students who had a strong growth mindset coupled with strong effort and ability attributions had consistently higher attainment value, utility value, and intrinsic value for their hardest course. Given that we found no relationship between students' mindsets and causal attributions when using standard regressions, this finding was particularly intriguing. This finding indicates that the other types of beliefs students endorse may be an important component of a network of beliefs that students use to understand their academic identity and behaviors. Specifically, when students made strong ability attributions alongside their strong growth mindsets, they had statistically significantly higher subjective task value than their peers who endorsed fixed mindsets or balanced mindsets with moderate causal performance attributions. Although these students had the same levels of subjective task value as their peers who had strong growth mindsets and only endorsed effort attributions, they were the only group to have consistently stronger motivation-related beliefs than students who had a strong fixed mindset. Furthermore, students who had strong growth mindsets and made strong effort and ability attributions had significantly higher self-concept of

ability than students who only endorsed a strong fixed mindset, even though these two groups of students did not statistically significantly differ in their course grades or GPA. This might indicate that regardless of actual grades received, the combination of a strong growth mindset and strong effort and ability attributions may be associated with stronger perceptions that one is good at a particular subject domain, even if it is not significantly associated with actual achievement. Perceptions that one is truly good in a course or subject domain are important because they help students make decisions about what courses to pursue, what majors to choose, and what majors to change. Further exploration of how these groups of students differ in the way they make decisions about their future course-taking and majors would be needed to fully understand this relationship. Results indicate that these beliefs likely function as part of a larger network of beliefs that on the surface may not appear related. Which other beliefs exist in this network and their impacts on student learning needs further investigation.

Evidence Suggests Having a Fixed Mindset May Not be Harmful for All Students

Dweck and colleagues have widely discussed the downside of having a fixed mindset (Blackwell et al., 2007; Dweck, 2000; Dweck & Molden, 2017; Henderson & Dweck, 1990) posing it as a psychological trait that should be discouraged in students. However, another perspective on our findings might suggest that having a fixed mindset may not always be harmful all the time for all types of students. For example, Dweck and colleagues suggest that having a fixed mindset will lead students to become obsessed with measuring their intelligence and when they are not satisfied with the measurement, they will likely give up instead of trying new ways to improve. For some students in our sample, the courses they selected as their hardest course may be required for their major but may not be a part of the subject matter for their major. For example, many students selected a non-major biology course as their most difficult course.

Once their major requirements are fulfilled, these students will no longer have any reason to pursue biology further or take on further challenges in biology. As such, it may not be problematic for students to have a fixed mindset for subjects that they already know they will not need for their future. This may also explain why students who had stronger fixed mindsets saw less relevance to their hardest course, saw being good at that course as a less important part of their identity, and experienced less enjoyment in the course compared with their peers who had stronger growth mindsets. It may be possible that these students simply have no interest in growing their intelligence in this subject domain because they know that this single course is the only time they will spend with the subject material.

Furthermore, the fact that students with a strong fixed mindset have lower motivation-related beliefs for their hardest course may not have any sort of detrimental impact on their achievement in their other courses in which they have a greater sustained interest. Findings in our studies indicated that students with a strong fixed mindset had lower self-concept of ability than students who had strong growth mindsets, regardless of actual performance, indicating that if students with a fixed mindset do not feel they are performing as well as their peers, they may be less likely to pursue further courses in this domain. However, this may be fine if these students have no interest or need to even pursue more classes. The present studies did not distinguish between non-major and major courses; thus, whether it is harmful for students to think in such a way about their non-major courses versus their major courses needs further exploration. Students do not necessarily need to feel intense motivation and strong positive feelings for every single course they take. They do not necessarily need to think that every course they take it extremely relevant for their future or important for their identity. Furthermore, if a student feels passionately about a specific course or subject and feel they are highly talented

in the domain, having a fixed mindset may not prove to be harmful for them. Such students may feel highly capable in these subjects and may not feel the need to grow their intelligence further.

Implications and Concluding Remarks

Millions of dollars have been devoted to the funding of mindset interventions and many schools have since implemented mindset training into their curriculum, hoping for a panacea to struggling and demotivated students. Few would disagree with the attractive idea that individuals should believe in the fact that their intelligence is a changeable construct with the potential to develop and increase over time with more effort and persistence. The generation of undergraduates in my sample did not grow up in schools that paid for mindset "brain training" to be implemented into their classrooms, and yet most of them already agree that their intelligence can change, begging the question of how students acquired these beliefs in the first place. It is possible that teachers and parents have been already nurturing beliefs about improvement and effort-focused learning all along. Further qualitative exploration into what a growth mindset and fixed mindset means to students is needed, including an understanding how these beliefs were influenced and nurtured. More research should be done to understand who is most impacted by such interventions and whose mindsets are in need of changing. The findings in this dissertation suggest that many students already strongly endorse one type of mindset already, without any type of intervention, but students may need additional support to fully benefit from growth mindset thinking. At least in our sample, having a growth mindset was not associated with better academic performance, but it was associated with stronger subjective task values for their courses. Just as many recent studies have claimed that mindset interventions only seem to benefit students who are struggling academically, findings from this dissertation may further temper the idea that implementing growth mindsets may serve as a magic bullet for increasing achievement

and motivation for all students. Given the lack of association between mindset beliefs and learning outcomes such as causal performance attributions, perceptions of performance, and academic performance indicators, future studies should explore what types of learning behaviors are most impacted by mindset interventions. Findings indicated that mindset beliefs are relatively stable, which is promising news for intervention studies, because when mindsets altered, they may be likely to remain altered for good.

If the present studies had indicated that general and course-specific mindsets differed, either at the mean-level or over time, current applied mindset research may want to tailor mindset interventions to be domain-specific. However, findings indicate that overall, general and course-specific mindsets are quite similar, suggesting the current interventions that assess general/global beliefs about intelligence are probably not missing any important information that might be gleaned from using course/domain-specific measures. Believing that their intelligence was malleable and endorsing effort and ability causal performance attributions was almost always associated with higher endorsements of motivational beliefs compared with only making effort attributions alongside a growth mindset. These findings have implications for future mindset interventions that may benefit from adding an additional component that encourages students to believe in their intelligence alongside their effort-focused endeavors. Given that these mindset interventions hinge on the idea that students should believe that they can grow their intelligence and abilities through seeking more challenges, encouraging students to also believe in harnessing this intelligence may be easily incorporated into existing interventions.

References

Aronson, J., Fried, C., & Good, C. (2002). Reducing the effects of stereo- type threat on African American college students by shaping theories of intelligence. Journal of Experimental Social Psychology, 38, 113–125. http://dx.doi.org/10.1006/jesp.2001.1491

Blackwell, K. L., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*(1), 246–263. doi:10.1111/j.1467-8624.2007.00995.x

Burns, K. C., & Isbell, L. M. (2007). Promoting malleability is not one size fits all: Priming implicit theories of intelligence as a function of self-theories. *Self and Identity, 6*(1), 51-63. doi: 10.1080/15298860600823864

Dweck, C. S. (2007). *Mindset: The new psychology of success*. New York, NY: Ballantine Books.

Dweck, C. S. (2015). Growth mindset, revisited. *Education Week.* Retrieved from http://www.edweek.org/ew/articles/2015/09/23/carol-dweck-revisits-the-growth-mindset.html

McCutchen, K. L., Jones, M. H., Carbonneau, K. J., & Mueller, C. E. (2016). Mindset and standardized testing over time. *Learning and Individual Differences, 45*, 208–213. doi:10.1016/j.lindif.2015.11.027

O'Rourke, E., Haimovitz, K., Ballweber, C., Dweck, C. S., & Popovic, Z. (2014). Brain points: A growth mindset incentive structure boosts persistence in an educational game. In CHI '14: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 3339–3348). New York, NY: Association for Computing Machinery.

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015).

Mind-set interventions are a scalable treatment for academic underachievement. Psychological Science, 26, 784–793. http://dx.doi.org/10.1177/0956797615571017

Rattan, A., Good, C., & Dweck, C. S. (2012). It's ok – not everyone can be good at math: Instructors with an entity theory comfort (and demotivate) students. Journal of Experimental Social Psychology, 48(3), 731–737. doi:10.1016/j.jesp.2011 .12.012.

Robins, R. W., & Pals, J. L. (2002). Implicit self-theories in the academic domain: Implications for goal orientation, attributions, affect, and self-esteem change. *Self and Identity, 1*(4), 313–336.

Shively, R. L., & Ryan C.S. (2013). Longitudinal changes in college math students' implicit theories of intelligence. *Social Psychology of Education, 16*, 241-256. DOI 10.1007/s11218-012-9208-0

Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., . . . Dweck, C. S. (2016). Using design thinking to improve psychological interventions: The case of the growth mindset during the transition to high school. Journal of Educational Psychology, 108, 374-391. doi:10.1037/edu0000098