

TEACHER BELIEFS: EFFECTS OF A TEACHER BASED MINDSET
INTERVENTION ON MATH STUDENT MOTIVATION AND ACHIEVEMENT

By

Christopher Seals

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ABSTRACT

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Social psychological interventions (SPI) have been found to be robustly effective for increasing student achievement, and are especially effective for students who face psychological threat due to their underrepresented identity (Yeager & Walton, 2011, Cohen & Sherman, 2014). The focus of growth mindset intervention research has centered student outcomes, as such, studies have largely ignored both the effects that interventions have on teachers themselves, as well as the role of teachers in implementing interventions. This is a problem, of course, because teacher beliefs are strongly associated with students' behavior and achievement (Handal, 2003) and may influence the effects of growth mindset interventions on student motivation. This dissertation used a pre-post experimental design to test whether a teacher-based growth mindset online intervention program influenced the beliefs and practices of teachers and the motivation of students. The sample includes 25 secondary math teachers and 1,653 students across nine schools. Contrary to the hypothesis, results showed that the intervention had no measurable effects on teacher beliefs and practices, though it did influence students' interest and mastery orientation in math. Additionally, student mastery orientation was found to be moderated by teachers' growth mindset beliefs and classroom practices. These findings have the potential to increase knowledge concerning the use of growth mindset interventions for teachers. Teacher-based growth mindset interventions may be an effective and efficient

method for enhancing teacher beliefs and practices to foster adaptable learning environments in math classrooms.

Keywords: social psychological interventions, teacher professional development, growth mindset, teacher beliefs, underrepresented student motivation, teacher efficacy, math efficacy, achievement goal orientation, teacher-based intervention, student value of math, teacher practices

This dissertation is dedicated to every educator in my family. For over 100 years, a member of my family has been a professional educator. This begins with my father's grandfather, Kirke Smith, who was the first academic dean of students at Lincoln Institute, a Black private normal school in Shelby County, Kentucky from 1912 to 1933. Since then, my family has had an educator in various positions from principals, teachers, and college professors. This includes grandparents, aunts and uncles, as well as my father, Alvin, a retired sociology professor and my mother, Chrysanthia, a previous English teacher, trainer and now pastor. My siblings, Keric and Dorcea, are both K-12 educators, and not long ago I married a beautiful K-12 math teacher, Gillian. This makes my first cousins, siblings, and I fourth generation educators and fourth generation-college educated African Americans. This is notable considering the lack of educational opportunities available to our people prior to and during the 20th century. I am beyond proud of my family's history as educators and even more proud to continue the legacy of learning in order to build our community.

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CHAPTER 1: INTRODUCTION

The lack of American student's engagement in their coursework has been well documented by researchers for decades (Uekawa, Borman, & Lee, 2007). Many researches have taken a keen interest in studying student engagement in math in particular, because it has been found that many students believe that their ability in math is inherent and therefore their skills cannot increase (Jonsson, Beach, Korp, Erlandson, 2012). However, social psychological scholars have found that adopting a growth mindset can lead to greater student motivation and achievement in math (Blackwell, Trzesniewski, & Dweck, 2007), and that students can build a growth mindset by completing a social psychological intervention (SPI). SPIs are often completed in one sitting and use psychological principles to change students' ability beliefs, construal of challenges, and/or sense of belonging to their community (Walton & Cohen, 2011). Research shows that SPIs are effective in increasing student health outcomes, student achievement, and student involvement (Yeager & Walton, 2011). The SPIs are also effective for underrepresented students (Claro, Paunesku, & Dweck, 2016) because SPIs relieve students of psychological threat (e.g., stereotype threat) by altering their beliefs over time, which will be further discussed in the literature review.

SPIs have been intensely studied over the past decade because of the robust long-term effects that they have on student outcomes (Yeager & Walton, 2011), and they are especially intriguing to researchers because some of them can be completed in one sitting (Paunesku et al., 2015) making implementation less strenuous for educators. The research on SPIs most often provides students with the intervention; therefore, this study placed the teachers as the subjects who will receive the SPI instead. Asking teachers to complete SPIs, as opposed to students,

could be easier to implement for educators. Furthermore, the one-sided focus on students in past studies poses a challenge because the social learning environment influences student learning experiences, and the learning environment includes the teacher. Since teachers are socializers of student learning (Handal, 2003), encouraging and assessing teacher beliefs could shed light on student beliefs and behavior. This study specifically explores how a growth mindset SPI for teachers impacts the teacher and affects student motivation and achievement.

The model in Figure 1 shows *growth mindset social psychological interventions* leading to students' *self-affirmation*, which then leads to *student outcomes* (achievement and behavior). This dissertation adds to the literature by testing the hypothesis that a teacher-based growth mindset intervention affects teacher beliefs and behaviors as well as student achievement and motivational beliefs. Testing motivation is important, of course, because it may shed light on the psychological processes by which growth mindset interventions can alter both teacher and students' behavior. This dissertation also tests the novel hypothesis that *teacher beliefs* moderate the effect of the teacher-based growth mindset intervention on students' outcomes.

Providing background on these issues, Chapter 2's literature review first discusses the theory that explicates how SPIs work, which includes a discussion of the mental processes that interventions inspire in users. I then discuss implicit theories of intelligence, often referred to as growth versus fixed mindset, and I will share past results from growth mindset SPIs. From there, I will discuss how teacher beliefs and practices impact student achievement, focusing specifically on how teachers' implicit theories of intelligence and related practices impact students' motivation and achievement. Finally, I explain the relationship between implicit theories of intelligences to other motivation constructs (e.g., goal orientation, self-efficacy, values) and to academic achievement.

CHAPTER 2: LITERATURE REVIEW

Social Psychological Interventions for Students: Context and Theory

In the United States, only 9% of college- educated underrepresented minorities have science, math, technology, or engineering occupations (National Research Council, 2011). Of the 9%, only 6% are career mathematics scientists (NSF, 2015). These facts illustrate the need for research that focuses on factors that impact math achievement. National data shows that white students are consistently outperforming than students from underrepresented backgrounds in educational achievement (Bowen, Chingos, & McPherson, 2009), this has been referred to as, the “Achievement Gap”. Researchers have implemented various programs to close the academic achievement gap between underrepresented and majority students. Many of these programs reflect a deficit-model of the achievement gap, the basic premise being that underrepresented students lack skills (e.g., fiscal management, study skills, academic preparation) and/or knowledge (e.g., financial resources) that, when acquired, would allow them to achieve at the same level as majority students (Engle, Bermeo, & O’Brien, 2006). Social psychological interventions take a different approach and begin with the assumption that individuals’ beliefs may contribute to their success.

There are relationships among students, their environment, and their academic performance (Steele & Aronson, 1995). The environment influences students’ attitudes and values toward schooling, which in turn, influences academic achievement (Eccles, Wigfield, & Scheifele, 1998). For example, a student who has family and school environments that promote math proficiency will be more encouraged to ask for help when struggling in math or pursuing difficult math goals. In a reciprocal manner, students’ academic achievement also shapes their environments, possibly reinforcing a stereotype or reinforcing the decision that a parent made to

put their child in an advanced course. SPIs intervene in these relationships by altering student beliefs (Yeager et al. 2013), which cause students to construe their experiences differently. This process is rooted in *self-affirmation theory* (Steele, 1988), which posits that individuals are motivated to protect their self-image, or judgment of one's own adequacy (Harter, 1988) as moral, positive, and successful.

For participants, social psychological interventions embedded with self-affirmation theory support self-worth and relieve stress in threatening environments (Cohen, Garcia, Apfel, & Master, 2006). The use of self-affirmation theory in educational interventions works to remind pupils of their positive character attributes, which leads students to see threatening events and information as less harmful and reduces the stress and possibility of developing a negative self-image (Cohen, Garcia, Purdie-Vaughns, Apfel, Brzusoski, 2009; Walton & Cohen, 2011). Further, the effects of social psychological interventions are believed to persist and have impacts on how participants will understand and explain future failures and challenges.

Self-affirmation theory describes how people cope with psychological threats to self (Steele, 1988), which is defined as the “perception of an environmental challenge to the adequacy of the self” (Cohen & Sherman, 2014, pg. 335). A person who experiences psychological threat often feels cautious, yet motivated to affirm self (Steele, 1988). Experiencing psychological threat can lead to either positive change or to maladaptive coping to keep their view of self as positive. Maladaptive coping promotes the pupil to focus on short-term goals that may stifle other long-term goals. For example, a student who is struggling in reading may begin to convince himself that he does not value reading. This maladaptive coping strategy allows the student to maintain his positive view of self as an intelligent person, inferring that if he did care then he would be good at reading. Yet, his new disengaged attitude toward reading

could impact the possibility of future success in reading. Additionally, psychological threat can consume other mental resources preventing the person from focusing on their task or activity (Steele, 1997). Finally, it is important to note that psychological threat can happen with every day classroom practices, activities, and interactions.

Self-affirmation theory describes how students may cope with psychological threat; therefore, many social psychological interventions focus on students themselves. However, the purpose of this research is to better understand the relationship between teacher beliefs and student outcomes, specifically as it relates to instilling a growth mindset in students. This study will administer a growth mindset intervention to teachers, with the expectation that they will promote, teach with, and live by a growth mindset and therefore instill the same growth mindset message within their students. Further, this study will explore how teacher beliefs may hinder or endorse the self-affirmation process of students, therefore possibly altering students' perceptions of environmental challenges.

Recursive Processes

As mentioned, the psychology that informs self-affirmation theory is important when considering a person who is attempting to maintain self-adequacy while facing psychological threat. Affirmations remind people of their psychological and social resources outside of the threat (Sherman & Hartson, 2011), which allows them to see threats as less harmful.

As a result, the individual is less occupied by fear or worry and the threat has less psychological impact on their well-being. Most importantly, these effects can be long-term because of the *cycle of adaptive potential* (Cohen & Sherman, 2014), which is a chain of interactions between the self and the social environment that breeds adaptive outcomes over a long period of time. The cycle of adaptive potential creates a recursive process within individuals whereby they continue to

construe the interactions with the environment as positive or adaptive. For example, a child who is tall for his age may stand out as more athletic when playing sports with his peers. Due to his height, he may score more goals and get more opportunities to play and practice, which is the environment affirming the idea that he is good at sports. These experiences develop his identity as an athlete fueling his desire to improve, which creates more affirmation.

The boy from my example will also have to face challenges as an athlete. He will have performances and practices where he may not reach his expectations and may feel disappointed. However, the affirmations that he has gained throughout the cycle of adaptive potential will work as reminders that help him continue to see himself as a successful and competent athlete even when he has bad days. The mechanism that triggers the adaptive cycle between the child and the environment, in this case, is the boy's height at a young age. This process is reflective of the role that growth mindset has on a SPI.

Implicit Theories of Intelligence

The present study adds to the literature on growth mindset SPIs by testing (a) whether a teacher-based growth mindset intervention can effectively impact teacher beliefs and teacher practices, and (b) by testing if the teachers' beliefs moderate the effects of the growth mindset intervention on student outcomes. Before discussing the role of teacher beliefs in particular, however, it is first important to understand the way that implicit theories of intelligence influence motivational dynamics.

A person's implicit theory of intelligence influences their behavior, choices, and motivation (Blackwell, Trzesniewski, & Dweck, 2007). *Implicit theories of intelligence* is a construct that has two opposing views on opposite sides of a continuum in which people see and understand their intelligence or abilities (Dweck & Leggett, 1988). For instance, on one side of

the continuum is an *incremental view of intelligence*, also known as a *growth mindset*, means that an individual believes that their intelligence or ability can increase, or is controllable. The other is an *entity view of intelligence*, or a *fixed mindset*, where a person feels that intelligence or ability is innate and uncontrollable (Schunk, Meece, & Pintrich, 2014). Those who possess a growth mindset are more likely to include knowledge or motivation in their definitions of intelligence as opposed to students who hold a fixed mindset, who are more likely to refer to capacity or abilities (Mueller & Dweck, 1998). Similarly, persons with growth mindset put more emphasis on effort when defining intelligence in comparison to fixed mindset students who put more emphasis on ability (Dweck, 2002).

During growth mindset interventions, students receive a message about the brain being able to grow like a muscle. From this perspective, intelligence is amendable (growth/incremental view) rather than fixed (entity view). When students adopt a growth mindset, they tend to take better advantage of campus resources (tutors, counseling, professors, etc.), and they work harder (Aronson, Fried, & Good, 2002). With a growth mindset, students may internally attribute failure (blame self), however, they are equipped with a high locus of control, believing that with hard work they can change future results. In a study by Aronson et al. (2002), Black and White college students wrote letters to middle school students supporting the idea that intelligence is plastic and can change. Results showed that the grade point average changed significantly for both Black and White students, and Black students reported increased identification with school. Furthermore, Black students' view of the importance of school and enjoyment of school increased more than that of their white counterparts and thereby shrinking the achievement gap between the two groups of students in this study. Moreover in another study, Blackwell, Trzesniewski, and Dweck (2007) found that growth mindset beliefs are associated with positive

strategies, positive goals, and adaptable attributions. Blackwell et al. (2007) taught urban middle school math students that intelligence is malleable. They found a positive change in classroom motivation and math achievement for seventh grade (middle school) math students with 52% Black population, 45% Latino, and 3% White and Asian.

Paunesku, Walton, Romero, Smith, Yeager, and Dweck's (2015) study is an example of another SPI study that manipulated implicit theories of intelligence. They presented a brief one-time online module to over 1,500 high school math students across 13 different high schools, and found a significant growth in grade point average in core academic courses. Specifically, the intervention in this study was most beneficial to poorly performing students as opposed to students who were doing well.

The intervention in my study is also founded upon implicit theories of intelligence and the benefit of adopting a growth mindset. The three aforementioned growth mindset studies (Aronson et al. 2002; Blackwell et al. 2007; & Paunesku et al. 2015) all found that growth mindset beliefs altered student achievement, academic related behaviors, and motivation for students from diverse racial/ethnic backgrounds, but only one of the three studies (Aronson et al., 2002) compared effects of the intervention based on racial/ethnic groups. In contrast, my study will compare intervention effects across race, which is hypothesized to be an important factor. Moreover, these three studies focused on student-based growth mindset interventions, not teacher-based interventions like the intervention proposed in this study. Additionally, the interventions in those studies did not highlight the impact that teacher beliefs may have on students' academic persistence and construal of a growth mindset. Moreover, only one of the three studies focused on math students exclusively (Blackwell et al., 2007), while the other two studies focused on college students (Aronson et al., 2002) and high school students in their four

core classes (Paunesku et al., 2015). In contrast, this dissertation leverages a teacher-oriented intervention that specifically targets math related student outcomes in middle and high school settings. Additionally, analysis of the outcomes between different racial/ethnic categories will be conducted.

Teacher Beliefs

In this study, teachers completed a growth mindset online intervention. The goal of the intervention, was for teachers to embrace what they learned from the intervention and use that knowledge to inform the way they taught, planned their lessons, and communicated with their students. Thus, prior to discussing how teacher beliefs influence students' outcomes, I must explain how or if teachers will be impacted by participating in growth mindset interventions.

Existing theory and research offer conflicting predictions about whether effects of mindset interventions will also generalize to teachers. We know from previously discussed research that growth mindset interventions produce positive student outcomes (Aronson et al., 2002; Blackwell et al., 2007; Yeager & Walton, 2011; Paunesku et al., 2015), but there is no extant research on the effects of growth mindset interventions on teachers. In fact, research on implicit theories of intelligence do not clarify whether the effects of either having growth or fixed mindset is dependent on age (Mueller & Dweck, 1998). Dweck (2002) stated that people with a growth mindset define intelligence based on effort and not ability, but this too is not limited to children or students. If teachers complete the intervention of this study, which will expose them to the growth mindset ideas, then I hypothesize that the teachers will be accepting of these ideals, which may alter their mindset beliefs. In turn, their growth mindset beliefs, that are associated to their mastery orientation (Dweck & Sorich, 1999), may influence student achievement (Butler & Shibaz, 2014).

Just as a student's own implicit theory of intelligence can alter their achievement and outcomes (Aronson et al., 2002; Burnette et al., 2013), teacher beliefs have also been found to influence student outcomes (Handal, 2003, Rattan, Good & Dweck, 2012, Stipek, Givvin, Salmon, & MacGyvers, 2001). Past research has shown that teachers look for various characteristics to determine a student's intelligence. For example, Harrison (2004) found that teachers felt that students' curiosity, memory, and numeration skills indicated that students were intelligent. A student's intelligence cannot be limited to these characteristics, therefore if a teacher is looking for these characteristics as indicators of intelligence, this can impact students' futures if they do possess some or all of what their teacher is looking for. This poses an equity challenge because teachers recommend students for future academic programs (Pajares, 1992), such as advanced placement courses or what colleges to apply to. Notably, there are clear implications on the education of students based upon teachers' beliefs. Unfortunately, how teachers develop these conclusions about students, however, can be due to their epistemological beliefs. Epistemological beliefs are a person's conceptualization of knowledge and knowing. Research has found that a teachers epistemological beliefs influence the teacher's classroom behaviors, classroom instruction, and student evaluation (Prawat, 1992; Hofer & Pintrich, 1997; Marland, 1998). From this, we can infer that teacher beliefs influence teacher behavior and can have a subsequent affect on student achievement. To expand on the effect of teacher beliefs and practices on student outcomes, next I explore past research that discusses how a teacher's growth mindset beliefs influences their students.

Teacher's Implicit Theory of Intelligence

Embedded within a teacher's epistemology are their beliefs about the malleability of intelligence (or mindset). Teacher's beliefs about intelligence are established prior to their

teaching career (Pajares, 1992), but if my hypothesis is correct, then teachers' beliefs may be altered by a growth mindset intervention. Studies show that a teacher's theory of intelligence influences their classroom practices in various ways including: how they praise students, the promotion of risk taking, how they present challenging activities, if they label students, if they grade students on timed assignments, and if they promote challenge over success (Dweck, 2010). Teacher's beliefs about intelligence are established prior to their teaching career (Pajares, 1992), but if my hypothesis is correct, then teachers' beliefs may be altered by a growth mindset intervention. The promise of shifting a teacher's theory of intelligence cannot be overstated, because teacher beliefs inform their teaching practice and their practice informs their belief regarding students (Sullivan & Mousley, 2001). Ultimately, a teacher's practice, beliefs, and communication style with their students directly impacts their student's implicit theory of intelligence (Bronson, 2007) and motivation (Richardson & Placier, 2001) because teacher beliefs impact teacher practice while practice also impacts beliefs (of student; Sullivan & Mousley, 2001).

Findings from previous studies have not proven that teacher implicit theories of intelligence impact student achievement (Haimovitz & Dweck, 2017). Haimovitz and Dweck (2017) reviewed studies that measured how teacher practices, not teacher beliefs, impact student motivation and achievement. A study by Park, Gunderson, Tsukayama, Levine, and Beilock (2016) asked 58 elementary teachers to report the extent that they used process-oriented (growth mindset; emphasized understanding material) learning strategies in the classroom versus person abilities (fixed mindset; emphasizing grades and performance) learning strategies. Teachers who used more person abilities learning strategies had more students with fixed mindsets by the end

of the school year. These findings support my argument that teacher growth mindset practices will impact student motivation.

Praising students is one of the most studied teaching practices in growth mindset literature and is informed by a teacher's implicit view of intelligence. Dweck (2010) argued that teachers should praise a student for their effort, persistence, and strategies used in order to obtain their goal because this sort of praise promotes a growth mindset in children (Bronson, 2007). This type of praise has the opposite effect of praising a student for being smart or telling a child "good job" when they earn a high grade, which promotes a fixed mindset. This sort of praise focuses on the outcome or performance, which the student may have little control over, while praising student effort focuses on the process toward the outcome, which is something that the student has full agency over. For example, Mueller and Dweck (1998) conducted a study where they asked over 400 fifth graders to complete an easy puzzle assignment. At the end of the task, the researchers told half of the students that, "You must be really smart at this" and they told the other half of students, "You must have worked really hard." Later, all of those students were given the opportunity to choose their next activity. The students were told that they could either choose the very difficult task or the very easy task. Results from her study show that 90% of the students who were praised for their effort chose the more difficult task, while majority of the students who were praised for their intelligence chose the easier task. Moreover, when asked to complete an even harder puzzle task in the third round, though all the students failed the task, students who were praised for their intelligence expressed more negative self-talk during the task. Finally, in the fourth round of tasks, all students were given the same puzzle task from the first round, but results showed that students who were praised for effort improved from their first score by 30%, while the intelligence praised students drastically dropped in performance. This

study illustrates that when a growth mindset is endorsed the students pursue growth and value effort, yet when a fixed mindset is endorsed students value looking smart. This study aligns with previous growth mindset literature which shows that students with growth mindsets persist when faced with challenges as opposed to students with fixed mindset (Dweck, 2010). This dissertation study differs from Dweck's (1998) puzzle study because it will not be in a controlled lab setting and the study is not task oriented. The measurements in this dissertation will take place at school and will ask students about their everyday perceptions of working with math and their math teacher. Conducting this study in the field allows me to better examine how the teacher hinders or endorses a growth mindset message in the students' everyday learning setting.

In an effort to explore how implicit theories of intelligence play out when teachers are communicating with students who are facing adversity, Rattan, Good, and Dweck (2012) manipulated college instructors into endorsing a growth mindset then gave them a paper scenario asking them to share how they would comfort their students when struggling with coursework. These researchers found that teachers who had more of a fixed mindset were more likely to kindly comfort the struggling students and not promote future engagement with math. Those comforted students reported low motivation and low expectations in math. Results from these studies support Dweck's (2010) argument that a teacher who endorses a growth mindset promotes risk taking, they don't easily label students, and they promote challenging activities and the effort put into the activities as opposed to promoting the students' outcome/performance of the activity. That study was not conducted in the everyday learning setting, which is different from this dissertation study being proposed.

A related study by Muenks, Miele, Ramani, Stapleton, and Rowe (2015) found that when parents have more of a fixed mindset, the students endorse performance oriented behaviors and

report being less engaged in math. Similar to parents, teachers endorse performance orientation when they have a fixed mindset (Rattan et al. 2012; Dweck, 2010; Mueller & Dweck, 1998). If my hypothesis is correct, and the intervention does effectively work on teachers, then teachers in the control condition, who have fixed mindset beliefs, will endorse less adaptable achievement behaviors and students' motivation will be influenced by these behaviors (Prawat, 1992; Hofer & Pintrich, 1997; Marland, 1998).

Teacher Conflicting Beliefs

Numerous confounding teacher beliefs play a role in math teachers' pedagogical practices (Handal, 2003; Stipek et al. 2001) as such, some beliefs may not consistently overlap with others. This incongruence can be seen in beliefs that teachers have regarding their own efficacy, in relation to their students. Teacher efficacy is the teacher's perception of his or her own ability to influence student learning (Tschannen-Moran & Hoy, 2001) and math efficacy is the belief in one's capability to complete a math task (Butz & Usher, 2015). For example, a teacher who promotes a growth mindset-learning environment through their teaching practices could also have low teacher efficacy or have bias toward students based on their gender or race/ethnicity. As previously discussed, a growth mindset can lead to a more sustained self-efficacy in a task (Dweck & Legget, 1998), but all teachers do not have the same efficacy beliefs and may be more or less impacted by a growth mindset intervention. Therefore, both teachers' math self-efficacy and teachers' teaching efficacy could play a moderating role in how a teacher's implicit theory of intelligence (or growth mindset) may hinder or endorse student motivation and achievement.

Moreover, Jonsson and Beach (2012) argue that teachers with a fixed mindset tend to classify or stereotype students more often than teachers with a growth mindset. Dee and

Gershenson (2017) discuss unconscious bias in which humans store experiences and later use those memories to make automatic decisions in the future, which includes subscribing to negative stereotypes of underrepresented groups. This implicit bias has been tested in past research in order to detect beliefs and attitudes that people try to hide or unaware that they have (Dee & Gershenson, 2017). A lab study by Gilliam, Maupin, Reyes, Accavitti, and Shic (2016) found that teachers had more severe perceptions of a student's behavior when the child was from a racial group different than their own. In their study, Gershenson, Holt, and Papageorge (2016) found that White high school math teachers had lower expectations for Black students. These teacher biases have direct impact on persistence and the racial/ethnic achievement gap (Dee, 2005; Dee & Gershenson, 2017). Additionally, if a teacher holds an unconscious bias based on race or gender, then these beliefs could counter the productivity of a growth mindset math classroom culture that the teacher is hoping to endorse. For example, if a math teacher has lower expectations of their female students, then the teacher may not endorse a growth mindset in the same way when communicating with students across genders. The teacher could praise the female student for her grade (performance) yet praise the male student for his effort (mastery), or visa versa depending on the teacher's implicit theory of intelligence.

Considering my hypothesis, a teacher's potential for unconscious group bias highlights the importance of measuring the students' perception of teacher mastery beliefs. Student perceptions of how their math teachers communicate with them about their pursuit of goals in math class may offer an authentic report of how/if the teachers endorse a growth mindset to all of their students, despite their social identity groups. Further, looking for group (e.g., gender and race) differences from the student reports will speak to potential trends in the teacher's mastery behaviors when working with their students.

In summary this study measured several teacher belief constructs: teacher growth mindset, teacher efficacy in math, teacher efficacy in teaching, and student perception of teacher's mastery goals for the student. Additionally, students' report of teacher growth mindset classroom practices is a measured outcome and teachers' completion of the intervention was measured as a manipulation check.

Motivational Dynamics

This section discusses how past literature has connected implicit theories of intelligence to three different motivation constructs: achievement goals, self-efficacy and the four value types (all of which will be discussed). Additionally, I hypothesize how these motivational constructs would fit in the cycle of adaptive potential after teacher participants have completed a growth mindset intervention.

Implicit Theory of Intelligence to Achievement Goals

Researchers have found that a person's goal orientation, or what they seek to achieve when starting a task, is highly associated to a person's implicit theory of intelligence (Dweck & Leggett, 1988). A *mastery/learning goal* is when a person is focused on building their competency, and a *performance goal* is when a person is most concerned with gaining positive judgment, from others, about his/her competency level (Dweck, 2002). Studies found that those with a fixed view of ability often pursue performance goals and those with a growth mindset tend to pursue mastery/learning goals (Dweck & Sorich, 1999). Research shows that mastery goals lead to more adaptive behavior including consistent pursuit of completing the goal when faced with a challenge. Research also shows that performance goals lead to more of maladaptive or helpless patterns of behavior, such as avoiding challenges (Dweck & Legget, 1988). Additionally, performance goals lead to weaker outcomes when faced with a challenging task, as

opposed to a mastery approach (Diener & Dweck, 1980; Dweck & Legget, 1988). Dweck and Legget (1988) also report, “In short, in the face of failure, helpless children exhibited negative self-cognitions, negative affect, and impaired performance, whereas mastery-oriented children exhibited constructive self-instructions and self-monitoring, a positive prognosis, positive affect, and effective problem-solving strategies (p. 258).”

The mindset intervention study conducted by Blackwell et al. (2007) not only found positive changes in math achievement but a positive relationship between learning goals and growth mindset beliefs as well. Also, other types of interventions have encouraged students to adopt mastery goals (e.g., Muis, Ranellucci, Franco, & Crippen, 2013). In addition to the results reported from experimental studies, Burnette, O’Boyle, VanEpps, Pollack, and Finkel (2013) completed an analytic review of implicit theories of intelligence and self-regulation in order to build a theoretical framework. They found that an individual’s mindset is predictive of their self-regulation process, which predicts goal setting and goal monitoring.

The present study measures how a growth mindset, endorsed from a teacher-based intervention, impacts the achievement goals of students. The relationship between these growth mindset and achievement goals is important to this study because it allowed me to use students’ achievement goals to describe the mental process by which the growth mindset intervention alters student behavior. Greater understanding of motivation dynamics within this mental process allows researchers to better understand the self-affirmation and recursive processes that take place after the growth mindset interventions.

Next, I explore the relationship between implicit theory of intelligence to self-efficacy, and implicit theory of intelligence to values. Both efficacy and values, like achievement goals, are being used to describe the mental process by which the growth mindset intervention

influences student behavior. Since the growth mindset intervention was given to the teachers in this study, teacher beliefs may moderate the relationship between the mindset intervention and the students' motivation and mental processes. This will be discussed further after exploring the relationship of a person's implicit theory of intelligence to the remaining motivational constructs.

Implicit Theory of Intelligence to Self-efficacy

Self-efficacy is a model of measuring motivation that stems from social cognitive theory. Social cognitive theory focuses on how people acquire knowledge, rules, skills, strategies, beliefs, and emotions through their interactions with and observations of others (Schunk et al. 2014). Self-efficacy is a personal and social construct that reflects an individual's belief in their ability to carry out or complete a task, or their perception of their own competency (Schunk & Pajares, 2005). There are four sources of efficacy: past accomplishment, vicarious experience, verbal persuasion, and emotional arousal (Bandura, 1977). Therefore a math student's current efficacy would be based on their prior success in math, how/if they have seen others navigate math, what others have told them about math, and how their experiences with math have made them feel.

Efficacy, however does not work alone in determining human behavior. Research has found that mastery goals elicit several adaptive motivational behaviors including enhanced self-efficacy (Harackiewicz, Durik, Barron, Linnenbrick-Garcia, & Tauer, 2008). Individuals with a growth mindset believe that skill and ability can grow (Dweck, 2002). Moreover, implicit beliefs of intelligence coupled with high or low efficacy induce varying behavior (Dweck & Legget, 1998). A performance-oriented individual with low or high confidence would have a lot of anxiety during challenging tasks and would prefer easy tasks. Mastery oriented individuals, despite confidence in specific task, still seek learning opportunities (Dweck & Legget, 1998).

A six-week mindset classroom intervention study by Schmidt, Shumow, and Kackar-Cam (2017) measured skill and control for both 7th and 9th graders. These authors randomly assigned science classrooms to the intervention condition or content writing control condition. One class per week was devoted to this intervention where students used the MindsetMaker® Brainology computer software to learn about brain growth and completed related activities. Findings from this study show that students in the control group steadily declined in perceived skill and control across the year, while students in the intervention group had no significant change in these two variables. Further, in a meta-analytic review by Lazowski & Hulleman (2016), the authors discuss a study that conducted a math intervention for middle school students (Schunk & Cox, 1986). Students in the experimental group received feedback that praised them for their effort while students in the control condition did not. Findings showed that students who received effort feedback grew in efficacy and academic achievement. Though this study was not a growth mindset intervention, having a growth mindset is based on the idea that intelligence/abilities are malleable based on effort (Schunk et al. 2014). Students who were praised for their effort increased in future efficacy. Both of these studies highlight how a growth mindset can be a predictor of self-efficacy. This dissertation also measured self-efficacy as a result of the growth mindset intervention participation, however my study differs from the aforementioned studies because my intervention was teacher-oriented. This suggests that the intervention will impact teacher beliefs, which may influence feedback messages that may also alter student efficacy outcomes.

Implicit Theory of Intelligence to Values

The construct of value comes from the motivation theory, expectancy-value theory, where Atkinson (1964) described complementary variables that produce an individual's

behavior. Value is a person's desire and yearning to accomplish a task (Wigfield & Eccles, 2000) and has four components: *intrinsic value*, the enjoyment from an activity or overall interest. *Utility value*, which is the future usefulness in a domain, *attainment value*, the importance in completing a task, and *cost beliefs* (effort cost), the negative consequence of engaging in the activity, (Trautwein et al. 2012). Essentially, for the three former value components, greater value in a task is predictive of motivated behavior, while lower cost beliefs is a predictor of motivated behavior.

A growth mindset is indicative of a mastery orientation (Dweck & Legget, 1988), and as previously mentioned, past research has found that mastery goals elicit several adaptive motivational behaviors, and one of those includes interest (Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002). Similarly, a growth mindset has also been found to nurture intrinsic motivation (Aronson, Fried, & Good, 2002). Similarly, a performance orientation has been associated to weaker intrinsic motivation (Heyman & Dweck, 1992). Moreover, interest is one of the most powerful predictors of future choice (Hidi & Harackiewicz, 2000).

A few growth mindset intervention studies have measured interest as an outcome. Schmidt et al. (2017) measured interest and learning for 7th and 9th graders. Similar to their findings on perceived skill and perceived control, results show that students in the control group declined in interest and learning, while students in the intervention group did not. My dissertation study will similarly measure interest as a student outcome from growth mindset interventions.

Utility, attainment, and cost belief values are not often measured in intervention studies that concern implicit theories of intelligence (growth/fixed mindset). Canning and Harackiewicz (2015) as well as Harackiewicz, Canning, Tibbetts, Priniski, and Hyde (2015) all completed a

utility values intervention and found increased utility value in course content for students in the intervention group. While the finding of these studies are valuable, they were not mindset interventions, but they do illustrate that growth mindset interventions can be being associated to utility value. Utility is a predictor of both interest and performance (Hulleman, Durik, Schweigert, & Harackiewicz, 2008), which makes utility a variable that should be explored in relation to growth mindset interventions. Therefore, utility value is measured in this dissertation study.

Concerning attainment value, Schmidt et al. (2017) conducted a mindset intervention study that measured the importance of completing a task. They found no significant change in importance in the mindset intervention condition. Despite this single finding, importance value in relations to growth mindset can be further explored and will be measured in this study. Finally, cost beliefs, or effort cost, are related to mindset in that mindset strongly predicts beliefs concerning effort (Blackwell et al. 2007; Bronson, 2007; Diener & Dweck, 1978). Performance-oriented students viewed effort and intelligence as inversely associated. Therefore a low effort to achieve success meant high intelligence, and a high effort to achieve success meant low intelligence (Dweck & Leggett, 1988; Dweck, 2010), while students with a mastery orientation viewed low effort success as a disappointment or boring, and they valued effort (Dweck, 2007; Dweck, 2010). This suggests that the effort for success would not have a great cost value for students with a mastery orientation. The mindset SPI study by Blackwell et al. (2007) did measure effort beliefs and found that having a growth mindset was positively related to effort beliefs, which are congruent with past literature.

Since one's implicit theory of intelligence is related to their goal orientation (Dweck & Legget, 1988), efficacy (Harackiewicz et al. 2008), and values (Dweck, 2010, Harackiewicz et

al. 2002; Schmidt et al. 2017), a person's mental process (cycle of adaptive potential) after completing a mindset intervention, can be explained with these motivational terms. However, judging from the discussion above, there are some motivational constructs, such as attainment value and utility value, that should be examined more in relation to growth mindset. This study tested the relationship between growth mindset and the four value types (described above) for students. Further, these motivational constructs can all be used to help describe how student's self-affirm to protect their self-image, after teacher participation in a growth mindset intervention. For example, a student that has completed a growth mindset intervention may put more effort into his/her proceeding schoolwork (Blackwell et al. 2007). When that student earns positive results, he/she will attribute their success to their greater effort (Dweck, 2010). Also, their new successful experience will heighten their self-efficacy (Bandura, 1977). This will lead them to continue to work hard and practice (Cohen & Sherman, 2014) because they trust that they can be more successful with persistence. As people in their environment (teachers or friends) notice this increase in both effort and outcomes, the student may be reinforced socially. More success resulting from the additional hard work and effort may lead to greater intrinsic value (Harackiewicz et al. 2002) especially if they began to identify with the domain that they are having heightened success. As the person faces a threat/adversity to their success while holding a growth mindset, they will attribute their failure to the lack of effort (Dweck & Legget, 1988). Additionally, they will pursue goals that build their competency and not goals that build others' judgment of their competency (Dweck & Legget, 1988).

Endorsing a growth mindset in middle and high school math pupils may engage students in the content, foster interest in math, and promote choices related to their future class enrollment. It may also enable them to identify with and value a future career in math or related

fields due to an increase in interest, utility, or importance in math, or a perceived decrease in cost of math. To investigate these claims, this study explored if a teacher directed growth mindset intervention fostered a mastery orientation, increased math efficacy, or promoted interest, utility value, attainment value, and cost beliefs for secondary math students.

Present Study

In summary, social psychological interventions have been shown to be especially effective in increasing achievement for students from underrepresented groups (Yeager & Walton, 2011; Bowen, Wegmann, & Webber, 2013) who face stereotype threat. This study was conducted with teachers at suburban schools, which have a low population of underrepresented ethnic students, and urban schools, which consist of many underrepresented ethnic students (Milner, 2006), despite differences in their local, underrepresented students may suffer from stereotype threat (Borman, Grigg, & Hanselmann, 2016) in both settings. Additionally, this study was conducted with secondary school teachers, who work with adolescents during the critical time when motivation and grades tend to decline, especially for Black and Latino students (Anderman, 2003). Implementing a growth mindset intervention for teachers in these settings allowed me to use achievement goal orientation, math efficacy and value beliefs to explore how recursive processes may lead to achievement for various identity student groups in math class, as an effect of the beliefs of the teacher.

Growth mindset interventions demonstrate effectiveness in past studies on student motivation and achievement, but they can be more deeply explored and welcomed by practitioners if there is more research that highlights how student motivational constructs may also be influenced by teacher beliefs. Prior research on growth mindset interventions have not typically engaged teachers and, instead, provided interventions directly to students (Blackwell et

al., 2007; Paunesku et al., 2015; Schmidt et al., 2017; Yeager & Walton, 2011). Though scholars have reported positive results, this approach ignores how teacher practice may support or undermine the intervention. Also, the question remains whether teachers who have experienced and who endorse the message from a SPI can inspire change in their students. As such, this study is the first to not only examine the efficacy of a teacher-administered SPI, but also the first to examine whether teacher beliefs moderate the SPI's efficacy on student outcomes (see Figure 1). The research questions that guide this study are listed below:

Research Questions

1. How does teacher participation in the growth mindset intervention (PD) affect TEACHERS':
 - a. Views of ability (mindset) in math?
 - b. Math self-efficacy (content)?
 - c. Teacher self-efficacy (pedagogy)?
2. How does teacher participation in the growth mindset intervention (PD) affect STUDENTS':
 - a. Views of ability (mindset)?
 - b. Achievement goals?
 - c. Math self-efficacy?
 - d. Value?
 - e. Academic achievement?
 - f. Perception of teacher's mastery goals?
- 2.5. Are there differential effects based on the race/ethnicity of the students?

3. Do teacher beliefs moderate the effect of the intervention on student motivation and achievement?

CHAPTER 3: METHODS

Participants

This study's participants were 6th- 12th-grade math teachers and their students. Table 1 summarizes both teacher and student demographic information by condition.

Teachers. The 25 (68% female, 32% male; 92% White, 4% African American, and 4% Asian American) teachers that participated in this study (60% middle school, 40% high school teachers) are at nine schools in one Midwestern state (44% urban, 44% suburban, 11% rural). The number of participating teachers per school ranged from one (4%) to eight teachers (32%), with an average of three teachers per school. Most teachers (i.e., $n = 13$; 52%) were within their first ten years of teaching, and 12 (48%) taught more than 10 years.

All teachers were randomly assigned to conditions, with 12 assigned to the business as usual (BAU) control condition and 13 to the mindset (intervention) condition. However, two teachers (Ms. Pumpkin & Mr. Bevinson) did not start nor complete the intervention and consequently were both assigned to the BAU condition group. In total, this means there were 11 (44%) teachers in the mindset intervention and 14 (56%) teachers in the BAU control. In support of the effectiveness of random assignment at the teacher level, there was no evidence of differences between the two conditions based on teacher's race/ethnicity $\chi^2(2, N = 25) = 2.06, p < .36$, sex/gender $\chi^2(1, N = 25) = 2.02, p = .65$, teacher's school $\chi^2(8, N = 25) = 12.52, p = .13$, and the amount of years teaching (greater or less than 10 years) $\chi^2(1, N = 25) = 1.07, p = .30$.

In the mindset group, the percentage of total teachers in each school ranged from 0% (0 teachers) to 27% (3 teachers) with a mean percentage of 11% and standard deviation (SD) of 12%. In the BAU group, the percentage of total teachers in each school ranged from 0% (0 teachers) to 36% (5 teachers), with a mean percentage of 11% (SD = 12%). These distributions

suggest that there were a relatively equal number of teachers in the mindset and BAU conditions across schools. Finally, one teacher (Mr. Chan) was a sub for the entire term in place of the original teacher (Ms. White), who was out for maternity leave for the entirety of the study. Thus, this study's data are based entirely on Mr. Chan.

Students. The study consisted of 1,653 participating students. In total, 844 (51%) of the students were male, while 794 (48%) were female with less than 1% identifying as non-binary gender. Participants were ethnically and racially diverse, with 224 (14%) identified as Black, 126 (8%) Asian, 120 (7%) Latino, 134 (8%) multi-racial, and 987 (60%) White. In total, 546 (33%) students also identified as being in the free and reduced lunch government program. Grade levels ranged from 6th- to 12th-grade, with 236 (15%) of the students in sixth grade, 466 (28%) in seventh, 444 (27%) in eighth, 166 (10%) in ninth, 137 (8%) in tenth, 101 (6%) in eleventh, and 96 (6%) in twelfth grade. Across the mindset group, the percentage of total students in each grade ranged from 2% (12 students in eleventh grade) to 32% (200 in eighth grade) with a mean percentage of 14% (SD = 10%). In BAU group, the percentage of total students in each grade ranged from 4% (45 in tenth grade) to 37% (383 in seventh grade) with a mean percentage of 14% (SD = 12%).

There was no evidence of difference between the two conditions based on students' sex/gender $\chi^2(2, N = 1,638) = 3.71, p = .16$ or students' free and reduced lunch status $\chi^2(1, N = 1,170) = 2.56, p = .11$. However, there was evidence of difference between condition based on race/ethnicity $\chi^2(5, N = 1,630) = 12.96, p < .02$, and grade level, $\chi^2(6, N = 1,646) = 210.43, p < .00$. For race, there were fewer total Black and Latino students in the mindset condition, but only minor differences in percentage representation between conditions. Moreover, when race was aggregated into two groups (i.e., 517 underrepresented minority vs. 1,113 White / Asian), there

was no evidence of difference between condition based on race/ethnicity $\chi^2(1, N = 1,630) = .78$, $p < .38$. Finally, because school and grade were dependent on the random assignment of the teacher, differences between conditions were expected and will be statistically controlled in all models. This indicates an equivalent distribution of students in the BAU and mindset conditions across gender, free lunch status, and underrepresented minority status.

Most importantly, students were automatically assigned to condition based on their math teacher's random assignment. Therefore, the number of students per school and grade was dependent on their teacher. See Table 2 for the number of students per teacher, separated by condition. There were 624 (38%) students in the mindset condition and 1,029 (62%) in the BAU condition. In the mindset group, the percentage of total students who belonged to each teacher ranged from 3% (17 students) to 21% (128) with a mean percentage of 9% (SD = 5%). In BAU group, the percentage of total students that belonged to each teacher ranged from 2% (17) to 13% (138), with a mean percentage of 7% (SD = 4%). A chi-square test for the effectiveness of random assignment could not be conducted for this variable because student condition assignment was based on their teacher assignment, therefore all students would be in one group and the chi square value is zero. Despite that limitation, the reported percentages support similar distribution of students in the BAU and mindset conditions across teacher.

In the experimental group, the percentage of total students in each school ranged from 0% (0 students) to 46% (284) with a mean percentage of 11% (SD = 15%). In the BAU group, the percentage of total students in each school ranged from 0% (0) to 54% (560), with a mean percentage of 11% (SD = 17%). The percentages are similar across condition however, there was evidence of difference between condition based on school $\chi^2(8, N = 1,653) = 550.67$, $p < .00$.

This indicates that there is non-equivalent distribution of students in the BAU and mindset conditions across schools.

Teacher Intervention Program

This study used a waitlist-control comparison on the participating teachers. Half of the participating teachers were randomly assigned to complete the online mindset intervention in late September, at the beginning of the school year, while the other half were given access to complete the mindset intervention after the study concluded. The business as usual (BAU) control group teachers, who were waitlisted, were not required to complete any training for the study, but were aware that their counterparts participated in a growth mindset intervention.

The mindset treatment group completed the online Mindsetworks® Mindsetmaker teacher professional development program. Mindsetworks® is an award winning interactive online program that provides teachers, students, and parents with growth mindset driven approach to learning and teaching. The content of the Mindsetmaker program modeled the intervention content of two previous studies: Blackwell et al.'s (2007) study and the online module used in Paunesku et al.'s (2015) study. Both interventions covered research that argues how intelligence and abilities strengthen with practice. Similar content is also used by studies that used Mindsetworks® Brainology program which is made for students and not teachers. Schmidt et al. (2017) is an example of a study that used Brainology for the students in their study. See Figures 3 – 5 for example screenshots of the online teacher intervention.

To be clear, as the lead investigator in this study, I did *not* administer the actual training on Mindsetmaker but instead provided the teachers open access to the online program. That is, the Mindsetmaker program is specifically an online professional development course that teaches educators, individually, about growth mindset while also providing tools, resources, and teaching

strategies for implementing a growth mindset culture in their classrooms and schools.

Mindsetmaker is based on research that supports that teacher math beliefs (Handal, 2003; Stipek et al, 2001), teacher implicit views of intelligence/mindset (Rattan et al. 2012), and feedback from teachers (Mueller & Dweck, 1998) influences student performance. Mindsetmaker, as an online multimedia course, was built to fit the needs of busy educators by being easily accessible online, providing tools/tips that can be used in the classroom. The lessons are broken into five parts so that educators can learn the fundamentals of growth mindset research. The five parts include one introduction module plus four full modules. Each module has a video lesson that teaches them about relevant research on growth versus fixed mindset and helps teachers to explore related classroom practices that are influenced by implicit theories of intelligence. There was also an online discussion forum where teachers share successes, and adversities, and ask questions of/to other teachers who were in the experimental group. Moreover, there were online assessments for teachers to learn about their own mindset beliefs.

The introduction module is an overview of mindset (implicit theory of intelligence) and motivation course, including tools and resources. Module 1 introduced growth and fixed mindsets, explained how mindset drives effort and performance, and discussed ways to assess student performance. Module 2 discussed how teachers' communication with students could affect student mindsets and shared language and practices that reinforce a growth mindset. Module 3 discussed research that share teaching practices that promote a growth mindset. Last, Module 4 discussed how endorsing a growth mindset improves student motivation, achievement and behavior. Module 4 also taught educators how to teach growth mindset study habits (see Figure 6). Each session took about 10 to 30 minutes each and teachers were asked to complete

the four modules across a 30-day period from September to October. The time between each module allowed teachers to reflect on and use the material in their classroom practice.

Sampling Procedure

The 25 participating teachers were recruited by word of mouth, email, and social media. If teachers responded, the make up of the study was explained before they agreed to participate. Prior to starting the Mindsetmaker intervention program, the teachers met with me to learn about the study that they were participating in and to learn why the study was important. Teachers and their administrators were also made aware of the time and energy they would need to devote to the study and of expectations of classroom time that was needed for the study.

The teachers completed the Mindsetmaker intervention program in September to October (Time 1), toward the beginning of school year. Before starting the intervention, teachers completed a survey that included scales on (a) teacher view of ability (mindset), (b) math self-efficacy, (c) teacher self-efficacy, (d) teacher work avoidance, and (e) teaching practices. Teachers also completed this survey in December (Time 2) of the school year. Teachers completed the surveys online and the results from this survey informed research questions one and three.

The student data collection timeline was similar to the teacher data collection. In October (Time 1), the students completed a survey that measures motivation dynamics. The motivation scales included (a) student's view of ability, (b) achievement goal orientation to math, (c) math self-efficacy, (d) value of math and (e) engagement. Additionally, the students were asked about their perception of their teacher's (f) mastery orientation toward goals and (g) teaching practices. Students were asked to complete this survey again in December (Time 2). Surveys were completed on devices with online access and these data allowed me to answer research questions

two and three. I also collected various forms student achievement scores (e.g., teacher made pre/post test, state standardized tests) at the beginning of the school year (Time 1) and student achievement scores in December/January. This allowed me to compare experimental growth mindset group to the waitlisted business as usual control group, also helping to inform research questions two and three.

For student data collection, I visited every school except two for Time 1. However, for Time 2, I only visited four of the nine schools. My role in data collection involved providing wireless tablets to the students that enabled them to complete the online surveys. Not all schools required my equipment so I did not have to visit every school.

The math teachers were rewarded with \$50 personal gift cards for the time they gave in their classroom for this study and for data collection. Students were not rewarded. I have been granted exemption through Michigan State University's Institutional review board (IRB) according to #1054491 since this study requires educational tests and survey procedures but results cannot put the human subjects at risk. Also, it was not possible to identify participants directly from collected data.

Measures and Covariates

Data were collected at two times (Time 1: September/October & Time 2: December) over the 15-week fall semester (see Figure 2 for overview of measurement plan). I, as the researcher, met with the teachers several times throughout the semester, including: before completing the intervention, after completing the intervention, and to administer the surveys to their students. The teachers and I administered the questionnaires to the students during their regularly scheduled math course. The surveys for both teachers and students presented each item with Likert scale response choices. The reliability (Cronbach's alpha) of each teacher and student

measured construct is reported in Table 4 and Table 5 summarizes the dependent variables for each research question. Appendix C also lists of all survey questions within each construct.

Teacher Measures

Implicit view of ability/intelligence or mindset. At Time 1 and Time 2, teachers' beliefs of the plasticity in their math intelligence was measured ($\alpha_{T1} = .96$; $\alpha_{T2} = .92$). The measure included three incremental items and three entity theory items (Dweck, 2007) and served as a fidelity check for mindset after teacher participation in the intervention. Items were answered on a seven point Likert scale from strongly disagree to strongly agree.

Math self-efficacy. At Time 1 and Time 2, perceptions of academic efficacy (seven items) were assessed ($\alpha_{T1} = .94$; $\alpha_{T2} = .92$). Items were adapted from Butz and Usher (2015) and were answered on a seven point Likert scale from strongly disagree to strongly agree, measuring teaching view of their own competence in math.

Teacher self-efficacy. At Times 1 and 2, the belief that teachers can or cannot be effective in teaching their own students was measured with this 8-item scale (Woolfolk and Hoy, 2001). This scale consists of two sub constructs, instructional practices ($\alpha_{T1} = .86$; $\alpha_{T2} = .81$) and student engagement ($\alpha_{T1} = .82$; $\alpha_{T2} = .89$). Items were answered on a seven point Likert scale from Never to Always.

Teacher mastery goals. At Time 1 and Time 2, students answered questions about their perception of their teacher's mastery orientation toward the students' work ($\alpha_{T1} = .81$; $\alpha_{T2} = .85$). This is a five-item scale, adapted from PALS (2000). Items were answered on a seven point Likert scale from strongly disagree to strongly agree.

Teacher practices. The measure of growth mindset teacher practices was created to include five questions that were answered by both the students (three items; $\alpha_{T1} = .61$; $\alpha_{T2} = .66$)

and teachers (four items; $\alpha_{T1} = .77$; $\alpha_{T2} = .74$) at both Time 1 and Time 2 to determine if teacher practices were consistent with growth mindset literature. Item one is “How often does your math teacher praise you for your intelligence?” Item two is “How often does your math teacher praise you for your effort?” Item three is “How often does your math teacher present challenging tasks as exciting?” Item four is “How often does your math teacher present easy tasks as boring?” and Item five is “How often does your teacher promote challenging work over successful work?” Each item was answered on a seven-point scale from never to always. These questions also explicitly state that they are addressing the orientation of challenging and/or easy tasks from the points of view of the students. Both exploratory factor analyses (EFA) and a confirmatory factor analysis (CFA) were conducted to assess construct validity and to examine factor invariance across time and across the condition groups for this created teacher mindset practice factor/construct.

Teacher work avoidance. At Time 1 and Time 2, three items were used to measure teachers approach to their work ($\alpha_{T1} = .86$; $\alpha_{T2} = .92$; Harackiewicz et al., 2008). Items were answered on a seven point Likert scale from strongly disagree to strongly agree.

Teacher familiarity with views of ability (growth/fixed mindset). At Time 1, two questions were asked of teachers to estimate how much exposure they have had to growth/fixed mindset literature and concepts. These answers were used as a control variable when comparing groups. The first question asked, “I have a high level of familiarity with the growth and fixed mindset concepts.” This question was answered on a seven point Likert scale from strongly disagree to strongly agree. Also at Time 1, teachers answered the question, “What previous experience do you have with learning/studying growth and fixed mindsets (views of ability).

*Click all that apply.” The options available included: (a) none, (b) not much, I only heard about

it, (c) read a blog or article or two, (d) read several blogs and/or articles, (e) attended a training and/or workshop, (f) read a book or journal article about it, (g) attended several trainings and/or workshops (h) read several books and/or academic journal articles about it, (i) hosted a training or workshop about it (j) hosted several trainings or workshops about it, (k) taught a class about it. Teachers were allowed to select as many options as they felt applied. This measure was used as a control variable when measuring teacher effects in RQ1.

Student Measures

Implicit view of ability/intelligence or mindset. This measure is the same as the teacher view of ability measure, above, but was answered by the students ($\alpha_{T1} = .83$; $\alpha_{T2} = .85$).

Mastery and performance goals. At Time 1 and Time 1, mastery approach (five items; $\alpha_{T1} = .92$; $\alpha_{T2} = .93$), performance approach (five items; $\alpha_{T1} = .93$; $\alpha_{T2} = .95$), and performance avoidance (four items; $\alpha_{T1} = .85$; $\alpha_{T2} = .89$) goals were assessed. Items adapted from PALS, 2000. Items were answered on a seven point Likert scale from strongly disagree to strongly agree.

Math self-efficacy. This measure is the same as the teacher math self-efficacy measure above but was answered by the student ($\alpha_{T1} = .91$; $\alpha_{T2} = .93$).

Task values and effort cost. At Time 1 and Time 2, intrinsic (six items; $\alpha_{T1} = .97$; $\alpha_{T2} = .97$), utility (four items; $\alpha_{T1} = .89$; $\alpha_{T2} = .91$) and attainment (six items; $\alpha_{T1} = .92$; $\alpha_{T2} = .92$) values are issued and adapted from Conley's (2012) procedure. Effort cost (five items; $\alpha_{T1} = .91$; $\alpha_{T2} = .94$) is issued at both times points and is adapted from the procedure of Flake, Barron, Hulleman, McCoach, and Welsh (2015). All except one item was answered on a seven point Likert scale from strongly disagree to strongly agree. Item five of the attainment construct measure was answered on a seven point Likert scale from not at all important to very important.

Student behavioral engagement. At Time 1 and Time 2, behavioral engagement (five items; $\alpha_{T1} = .86$; $\alpha_{T2} = .88$) is issued and adapted from Skinner, Furrer, Marchand, and Kinderman (2008). Items were answered on a seven point Likert scale from strongly disagree to strongly agree.

Academic achievement. Achievement score data varied from school to school. Four of the five sixth grade teachers had their students complete the Fast Bridge Learning aMath assessment, which is an option for state testing. Other teachers provided pretest and posttest data on teacher made math tests, and some schools provided first term (October) and second term (January) math grading reports, scored by the teacher.

Data Analysis

Preliminary analyses consisted of missing data analysis and examining the descriptive statistics and bivariate correlations of each dependent variable. As noted, exploratory and confirmatory factor analyses were also performed for the teacher practice variable.

Primary analyses. Research question one (RQ1) required that I use a repeated measures multivariate analysis of covariance (MANCOVA) to measure change in teacher motivation and change in practices from Time 1 to Time 2, with teacher's condition assignment serving as the predictor. The covariates in this model include teachers', gender (male or female), years of teaching (greater or less than ten years), and familiarity with growth mindset (continuous variable). Six dependent variables were used in the model, including (a) teacher growth mindset, (b) teacher efficacy in math, (c) teacher efficacy in instruction, (d) teacher efficacy in student engagement, (e) teacher work avoidance, (f) student rated teacher mindset practices, and (g) teacher rated teacher mindset practices. The MANCOVA was conducted using SPSS software. For RQ2 and RQ3, I used a 3-level (teacher, student, observation) hierarchical linear model

(HLM or multilevel model; West, Welch, & Galecki, 2014, Chapter 7). A separate HLM was conducted for every dependent variable using the teacher's condition assignment as the predictor variable, with the key test of the mindset intervention being the two-way interaction between Time and Intervention. This analytical approach accounts for the lack of independence among repeated measures nested within students and students nested within the same class (teacher). For RQ2.5, a three-way interaction (race X time X intervention) was added to each model. Likewise, RQ3 used the same modeling strategy as RQ2, but used the teacher outcomes (dependent variables) as moderators. For RQ3, the teacher outcomes were added to the models to create a 3-way interaction with time and intervention. Also, the dependent variables in RQ3 also only included student dependent variables that showed significant change in the interaction variable (time x intervention) from RQ2, as well as teacher growth mindset practices (teacher responses). The covariates in all HLM models included race/ethnicity, sex, school, grade level, and free or reduced lunch status. Moreover, SAS University Edition software was used for RQ2 and RQ3.

CHAPTER 4: RESULTS

Preliminary Analyses

Missing data analyses. The 25 participating teachers had no missing data at Time 1 or Time 2. Of the 1,653 total participating students, 1,548 (94%) of the students completed the Time 1 survey and 1,300 (77%) completed the survey at Time 2. Thus, 344 (21%) of the Time 1 participants did not participate at Time 2. Also, 104 (6%) of the Time 2 participants did not participate at Time 1, leaving 1,195 (72%) students who participated at both time points. The sampling procedure for this study allowed participants to be included in the analysis if at least one survey had been completed.

Little's MCAR test (Little & Rubin, 2002) was used to assess whether missingness was significantly related to dependent variables and predictors. Missing data ranged from 0 and 3% across all survey items and demographic data, and Little's MCAR test was not statistically significant at Time 1, $\chi^2(10) = 14.04, p = .171$, or at Time 2, $\chi^2(10) = 13.27, p = .209$. This finding strengthens confidence that missing data were missing completely at random (MCAR).

Factor invariance. Unlike most of the dependent variable measures in this study (see Table 4), the teacher growth mindset practice scale had cautionary reliability scores ranging from $\alpha = .61$ to $\alpha = .77$. To assess construct validity across time and condition group, I therefore conducted an exploratory factor analysis (EFA) at Time 1 (see Table 6) and at Time 2 (see Table 7) for both student and teacher response data. The student response data was randomly split in half prior to the EFA. Results indicated that items two, three, four, and five loaded onto the teacher practice construct for teachers, whereas only items two and three loaded onto the teacher practice construct for students. I then conducted an additional EFA with only items two through

five (see Table 8), and findings showed that only items two, three, and five loaded onto the teacher practice construct for both teachers and students.

When examining change over time, longitudinal measurement invariance tests examine if changes are due to variability in measurement over time versus changes due to the condition (independent variable) over time. Before the main analyses I tested for measurement invariance across time using confirmatory factor analysis (CFA) in R (Ihaka & Gentleman, 1996) with half of the collected data from the students. Findings show that factor loadings for the configural invariance model were acceptable at both Time 1 and Time 2 (see Table 9) and that model fit was also acceptable (see Table 10). CFA findings strengthen confidence that changes to the dependent variable over time are not due to variability in the measure. Therefore in this study, the teacher growth mindset practices scale was measured with items two through five for teacher responses (4 items total) and with items two, three and five (3 items total) for student responses. However, due to the low reliability of teacher mindset practice, related findings were interpreted with caution. The sample size was too small to conduct a CFA of the teacher mindset practice measure with teacher response data.

Bivariate correlations and descriptive statistics. To examine the convergent and discriminant validity of all of the motivational outcomes that were collected, bivariate correlations were examined for both Time 1 and 2 motivation constructs and outcomes. Correlations among the variables were consistent with prior research for teacher responses (see Table 11) and student responses (see Table 12). From the teacher data, teacher efficacy in student engagement was positively correlated with growth mindset, math efficacy, and teacher efficacy in instruction. Moreover, teacher mindset practices were positively correlated with each

construct except work avoidance. Further, for students, interest was positively correlated to utility, attainment, mastery, math efficacy, and behavioral engagement.

Given the use of different items to measure teacher rated (items 2, 3, 4, 5) and student rated (items 2, 3, 5) mindset practices, it was important to test whether these two variables exhibited similar patterns of correlation with each other regardless of whether they included the same items (i.e., 2, 3, 5) or if the teacher-rated mindset practices also included Item 4. The correlation between teacher-rated (items 2, 3, 4, 5) and student-rated (items 2, 3, 5) mindset practices was $\beta = .21$ at Time 1 and $\beta = .19$ at Time 2, which represents a weak correlation. When Item 4 was excluded from the teacher response, the correlations remained weak $\beta = .25$ at Time 1 and $\beta = .20$ at Time 2. This suggests that teacher-rated response about their growth mindset practices was consistently *weakly* related to student-rated mindset practices whether Item 4 was included or not.

The means and standard deviations were also examined for each outcome and reported in Tables 13 (teacher responses) and 14 (student responses). Teachers in the mindset condition showed slight increase in growth mindset, math efficacy, teacher efficacy in instruction, and teacher efficacy in student engagement from Time 1 to Time 2. Students in the mindset condition showed slight decreases in all variables, from Time 1 to Time 2, except for math efficacy, growth mindset, and interest.

Primary Analyses

Research question 1 (RQ1). Analysis indicated that the intervention did not affect teacher beliefs or teacher practices from Time 1 to Time 2 (see Table 15). Teacher race was excluded from this analysis because a T-test for each dependent variable showed that there were no significant differences between teachers based on race. Also, a dummy variable for IJHS, and

a dummy variable for PHS were included in the model. These two schools had a large amount of teachers (8 in IJHS and 5 in PHS) compared to the other seven schools that each had two or less teachers. Adding dummy variables helped to control for the school of each teacher, when comparing the teachers in IJHS and PHS to the remaining teachers in the study.

Interestingly, results showed that work avoidance was significantly different across the gender of the teachers $V = .48, F(1, 18) = 16.91, p < .01$. Also, teacher efficacy in instruction was significantly different across the amount of years teaching (more than versus less than 10 years) $V = .248, F(1, 18) = 5.94, p = .02$. Moreover, the growth mindset of teachers ($V = .198, F(1, 18) = 4.54, p = .05$) and the work avoidance of teachers ($V = .202, F(1, 18) = 4.55, p = .05$) were marginally different across teacher's prior familiarity with growth mindset literature. There were significant gains in work avoidance from Time 1 to Time 2, $V = .357, F(1, 18) = 10.01, p < .01$, but this effect did not apply to the intervention group exclusively.

Research question 2 (RQ2). Looking at the effects of the teacher based intervention on student motivational outcomes and achievement, the analysis showed significant gains for students in the mindset condition from Time 1 to Time 2 for interest in math $\beta = .25, SE = .08, p < .01$ (Table 19), mastery orientation in math $\beta = .15, SE = .07, p = .02$ (Table 23), and surprisingly, a *decrease* in achievement $\beta = -2.08, SE = .86, p = .01$ (Table 28). However, the achievement results should be interpreted with caution as they only represent the data of four sixth grade teachers (Ms. Reed, Ms. Taylor, Ms. Fey, and Ms. Poller) whose students completed the Fast Bridge Learning aMath assessment. These teachers were in three different schools and this analysis included 123 students. Ms. Poller and Ms. Fey were at the same school (MMMS) and were both assigned to the mindset condition while the other two teachers were assigned to the control condition. Possible decrease in scores could be a function of the school setting and

student population at one school as compared to the other two schools. A more diverse sample could help with analysis in the future.

RQ2.5 looked at the differential effects of the intervention on student motivation based on race. Results showed a marginally significant decrease in cost for underrepresented minority students in the mindset intervention group from Time 1 to Time 2, $\beta = -.30$, $SE = .15$, $p = .05$ (Table 22). Complete findings for RQ2 and RQ2.5 are in Tables 16 to 28.

Research question 3 (RQ3). Looking at teacher beliefs as potential moderators of the intervention on student outcomes, I found that teacher growth mindset had a marginal effect on student growth mindset from Time 1 to Time 2, $\beta = .23$, $SE = .11$, $p = .04$ (Table 29), and teacher growth mindset had a significant effect on teacher-rated teacher mindset practices from Time 1 to Time 2 $\beta = -.47$, $SE = .12$, $p < .01$ (Table 31) for teachers in the mindset condition. These findings suggest that a teacher's growth mindset influences the strength of the relationship between the intervention and both students' growth mindset beliefs and teachers' practices. Specifically, in the mindset condition, student growth mindset beliefs increased over time along with teacher growth mindset beliefs. Moreover, teacher practices tend to increase overtime for teachers in the intervention, but teachers that have a greater growth mindset used less teacher-rated mindset practices. This finding is contrary to the hypothesis that a teacher's mindset beliefs would have a positive relationship with his/her mindset teaching practices.

I also found that teacher efficacy in instruction had an effect on teacher-rated teacher practices from Time 1 to Time 2, $\beta = -.11$, $SE = .05$, $p = .03$ (Table 31). For teachers in the intervention condition, this finding suggests that as teachers' teaching efficacy increased, their growth mindset teacher practices decrease. This finding also counters my hypothesis that efficacy is positively related to mindset practices.

Finally, I found that student-rated teacher practices had a significant effect on student mastery from Time 1 to Time 2 $\beta = .19$, $SE = .03$, $p < .01$ (Table 31), and a marginal effect on student interest from Time 1 to Time 2 $\beta = .09$, $SE = .04$, $p = .04$ (Table 31) for students (and teachers) in the mindset condition. These findings suggest that teacher mindset practices influences student interest and mastery orientation toward math. Though students' mastery orientation decays over time for students in both conditions, students in the mindset condition teacher practices (student-rated) showed a deceleration of their decay of mastery overtime. Conversely, students in the mindset condition exhibit interest increases overtime. Evidence suggests that teacher practices boost the increase of interest in students. There were no potential moderators of the intervention on student achievement (Table 30).

Summary of Results

Correlations among the variables were consistent with prior research for teacher responses (see Table 11) and student responses (see Table 12). Teacher growth mindset beliefs did not show strong correlations with other measured constructs. The lack of congruence could be attributed to teacher and student's desire to answer questions in ways that are socially desirably, or that are favorable to others, therefore decreasing the correlation coefficient. Due to recruitment for this study, all teachers were aware that this was a growth mindset project and they may have been primed to report highly of their views of growth versus fixed mindset. Also, teacher-rated mindset practices and student-rated teacher mindset practices were weakly correlated, implying that students and teachers had different views of how teachers communicated and worked with their students in the classroom learning setting.

Concerning RQ1 and RQ2, teachers did not show direct changes in beliefs or practices by being in the intervention condition. Teachers and students also did not show changes in

growth mindset beliefs. This finding opposes my hypothesis that teachers and students in the mindset condition would increase in growth mindset beliefs. This lack of intervention impact may point to the importance of time needed for significant effects in mindset beliefs to become evident. However, students in the classrooms of teachers in the growth mindset condition did show increases in both mastery and interest. This would imply that teachers are doing something different, but that change was not captured in the analyses for RQ1 and RQ2. The findings from RQ3 shed more light on what teachers in the mindset condition are doing differently, suggesting that a teacher's growth mindset beliefs, efficacy in instruction, and mindset practices influence student motivation. Therefore overall findings indicate that the teacher-based intervention showed measurable effects on the teachers and students in the growth mindset intervention group. Moreover, students' racial status, as underrepresented minorities in the intervention group, had an effect on cost, showing differential effects in race over time concerning the worth of the effort that is put into math.

CHAPTER 5: DISCUSSION

This study relied on self-affirmation theory and recursive processes to explore how the impact of a growth mindset intervention, given to math teachers, would impact teachers and how those teacher effects would affect students' motivation and achievement. It was found that teachers were not directly affected by their participation in the mindset intervention. However, students who had teachers in the mindset condition were affected by their teachers' participation. This finding is interesting because these two findings (that teachers were not noticeably effected by the intervention, but their students were) seemingly contradict one another. Students can only be influenced by the intervention if there was a change in their teacher's behavior. The results from the third research question help explain the changes in teacher beliefs and behavior, which are not evident from the results of the first two research questions. I will use the measured motivational constructs to shed light on the psychological processes by which the growth mindset intervention and teachers beliefs and practices alter students' behavior.

Research Question 1: Intervention Effects on Teachers

I hypothesized that teacher beliefs and teacher practices would increase as a result of participating in the growth mindset intervention. However, as aforementioned, there were no significant effects to support my hypothesis. Yet, in favor of my hypothesis, and as already mentioned, there were gains over time in teachers' growth mindset, math efficacy, efficacy in student engagement, and practices (student responses), but they were not statistically significant gains. Gains in these four constructs would present themselves as a teacher recursively using self-affirmation to remind themselves of the growth mindset lessons that they have learned from the intervention. Theory would also suggest that this affirmation process happens when teachers are faced with challenges in the classroom. The act of teachers self-affirming with messages about

growth mindset would lead to more practices in the classroom that are influenced by the growth mindset intervention. Though the gains in these variables were not significant, perhaps with more time between Time 1 and Time 2, significant gains in these various motivational constructs would be exhibited. This is congruent to past mindset studies, which showed that significant gains in motivation and behavior took as long as a year to become apparent (Aronson et al., 2002; Blackwell et al., 2007).

Research Question 2: Intervention Effects on Student Outcomes

I hypothesized that students with teachers in the mindset condition would show significant gains in motivation from Time 1 to Time 2 and I did find significant increases in both student interest and student mastery. As previously discussed, mastery is related to growth mindset beliefs (Muis et al. 2013; Burnette et al. 2013; Dweck & Legget, 1988) and mastery is also indicative of interest (Butler & Shibaz, 2014) therefore my findings are consistent with past literature. What is not clear from the findings from RQ1 and RQ2 is how teachers influenced these changes in student motivation. From the findings of RQ1, there were no significant gains in either teacher beliefs or teacher mindset practices but findings from RQ2 lead me to infer that teachers in the growth mindset intervention must be doing something to positively influence student interest and mastery orientation.

Results from RQ2 only show significant gains in two of the dependent variables (interest and mastery), however nine of the 13 outcome variables illustrate that students in the growth mindset condition did not decline in these constructs as rapidly as their counterparts in the control group (see tables 16 through 28). This was true for the following student outcome variables: growth mindset, perception of teacher mastery, teacher practices, utility, attainment, cost, performance approach, math efficacy, and behavioral engagement. My findings align with

past studies, which have indicated that growth mindset interventions didn't specifically increase motivation constructs of the student, but they did slow down the decay of that motivation in students (Schmidt et al. 2017; Blackwell et al. 2007). Though these changes were not significant, past studies would suggest that more of these outcomes could have had significant gains if the duration of time between the measures in this study were stretched across a full year instead of one semester.

Findings from research question 2.5 were not robust and did not offer much information concerning how race and ethnicity interact with the intervention over time. However, cost, was the one variable where a significant interaction was found (Table 22), implying that a growth mindset classroom endorses underrepresented minority students to see math as less of an expense or burden. This is a unique finding and could be explained by students who are facing psychological threat using the messages about growth mindset to protect their self image (Sherman & Hartson, 2011) when approaching math and therefore not perceiving math as threatening, burdensome, or costly. The psychological process of the student would be similar to that of the teacher in using messages of growth mindset to self-affirm when facing challenges in math. Yet, RQ1 does not expose how those mindset messages are given to the students. The findings from RQ3 however, do shed light on how the teacher passes messages of growth mindset to their students.

Research Question 3: Teacher Beliefs as a Moderator for Student Outcomes

I hypothesized that teacher beliefs and teacher practices would moderate student motivation. I found that teacher beliefs and student-rated teacher practices are a moderator of the mindset intervention on student mastery orientation in math, student interest in math, and student growth mindset in math from Time 1 to Time 2 (Table 29). Though teacher beliefs and practices

do not seem to be influenced by the intervention from the RQ1 findings, the RQ3 findings indicate that teacher beliefs and practices do have an effect on students in the intervention group over time. Teacher growth mindset beliefs were significant as a moderator of the intervention on student motivation, yet what is most intriguing is that teacher practices played a stronger role as a moderating variable (Table 31) for the effects of the intervention on student motivation.

A potential interpretation of these findings is that students that were paired with teachers whose initial growth mindset was high and who were then treated with the intervention grew the most in their growth mindset. This is in direct contrast to students whose teachers were in also the mindset group and had teachers with a low initial growth mindset, students in this group decreased in growth mindset (see Figure 7). One explanation for this may be that teachers with high growth mindset experienced confirmation bias due to their participation in the intervention, which reinforced their sharing of growth mindset messages with their students. In comparison, teachers with low growth mindset may have been more skeptical of the new information and less willing to share positive messages about growth mindset to their students. Moreover, the findings concerning student rated teacher practices show that the more growth mindset based their teachers' practices were, the higher the students' mastery orientation and interest is in math, despite condition (see Figure 8 & 9).

The increase in interest and the maintaining of mastery by students in the mindset condition can be credited to the intervention because the intervention gives strategies for teachers to use in the classroom. Such strategies included how teachers praise students, label students, and promote challenging tasks. These classroom practices reinforce ideas of growth mindset for students, allowing the students to use growth mindset messages to self affirm when faced with challenging math tasks.

Moreover, the moderating effects were convoluted because both teacher growth mindset and teacher efficacy in instruction have negative (moderating) effects on teacher mindset practice (teacher-rated) over time, which is contradictory to motivation literature. Teachers in the intervention condition who had a high growth mindset decreased in teacher-rated teacher mindset practices, while teachers with low growth mindset increased in mindset practices (see Figure 10). This finding could suggest that teachers with low growth mindset have more room to grow and change their practices as a result of being in the intervention. This finding however, seems to be counter intuitive to the finding above where teachers in the mindset condition with low growth mindset decreased student growth mindset. It seems counter intuitive for student growth mindset to decrease while teacher mindset practice increase. This conundrum speaks to the differences in student perception versus teacher perception of teacher practices. Additionally, teachers with high efficacy in instruction claim to increase teacher rated mindset practices due to participation in the intervention while teachers with low efficacy in instruction do not increase (see Figure 11). All of these findings, however, illustrate the importance of teacher practice in this discussion, similar to recent studies that argue that it is teacher's growth mindset practices (Park et al. 2016; Haimovitz & Dweck, 2017) that specifically have an effect on student motivation and behavior.

Teacher practices. I want to remind the reader that my teacher practice scales had tenuous reliability scores and have not been validated by previous studies. One of the primary findings of this study is from RQ3 which suggests that teacher beliefs (growth mindset and efficacy) influence teacher-rated mindset practice overtime for the mindset condition. Additionally, subsequent findings in RQ3 show that student-rated teacher practices influence student motivation (mastery and interest) in math over time. This flow of logic leads me to infer that the beliefs of teachers shape teacher practices, and, in turn, influence student beliefs in

education. Though this flow of logic makes sense, it would be unsubstantiated in this study because the teacher mindset practice measure had low correlations when comparing teacher responses to student responses. Low correlation between these two measures weakens the evidence that teacher beliefs lead to teacher practices then to student beliefs. Nevertheless, this is an intriguing finding and should be explored in future studies via an enhanced teacher practice scale. An enhanced teacher practice scale would increase the number of items in the scale to measure two latent variables instead of one overall variable. The two latent variables would include (a) praising students, measuring how teachers communicate with students concerning effort and outcome, and (b) promoting tasks, measuring how teachers communicate with students concerning challenges and ease of tasks. Moreover, I believe that the students' account of teacher practices is more useful for future work because it speaks directly to what the students are experiencing in the classroom as opposed to what the teacher thinks they are doing or what their intentions are, which explains why RQ3 had findings where student-rated teacher practices moderated the relationship of the intervention on student mastery and on student interest.

Limitations & Delimitations

There are several limitations within this study. The first limitation is teachers' conditional or inconsistent attribution of the growth mindset concept to different types of people or to different skill set types within different learning contexts. Though a teacher may comprehend the importance and use of growth mindset, they may not believe that all of their students have the same propensity to grow. In this case, they may not treat all their students as if their math ability is malleable, which impacts their practices and ultimately, student outcomes. The possibility that this may occur is why RQ 2.5 is of great importance to research. This is why research question 2.5 is important.

In the same way that a teacher may not believe that all student ability is malleable, they may also not consider that the malleability of abilities applies to all domains (e.g., math versus sports, versus reading, or social skills, etc.). Not fully adopting growth mindset as a universal concept of malleable intelligence/abilities may have altered the mechanism that allows the teacher's beliefs to change, and therefore could alter their teaching practices and interaction with students. This study however, required that the teachers complete the measure for their implicit view of ability, which works as a fidelity check for the growth mindset program. However, as mentioned, there were no significant changes in teacher growth mindset, thus, making teachers' adoption of the growth mindset concept unclear.

The second limitation of this present study is that I did not ask teachers for examples of lesson plans, nor did I inquire about their pedagogical beliefs. These data could have provided information, which could contextualize teachers' approach to the classroom and their application of a growth mindset, these teacher materials could have helped me to better understand and nuance teacher beliefs. This information also could have also served as a measure of effectiveness of the mindset intervention. This study, however, included a group of math teachers at various schools, in different settings (e.g., urban, suburban, rural), in neighboring school districts, and in both high school and middle schools. This hopefully means that teachers of various pedagogical philosophies were represented in this study, but the diversity of teachers does not guarantee nor identify which teachers have varying pedagogical beliefs. In future studies, qualitative methods should be considered in effort to best address the previous two limitations.

When considering diversity of the sample, this study's participant pool was diverse in the ages of students and the race/ethnicity and socioeconomic status of both students and teachers.

Yet, the sample was taken from teachers who are in neighboring school districts within the central area of one Mid-western state. This limits the broad generalizability of my findings, so future studies should consider collecting data in various states.

The greatest limitation in this study is the restricted time. Past growth mindset interventions, which have been issued directly to students, have sometimes taken up to one academic year to show significant gain in motivation, achievement, and behavioral outcomes (Aronson et al., 2002; Blackwell et al., 2007). By contrast, this study tested for motivation and achievement gain in as little as one semester (two plus months) and there are growth mindset intervention studies that have found psychological and motivational gains in one semester (Paunesku et al., 2015; Yeager et al., 2016). Yet, since this study had the teacher (instead of the student) receiving the intervention, this time span may not have been enough to render student results, as such, future studies should consider collecting student data for up to one or two years later.

The fifth limitation concerns the Mindsetmaker platform, an item that is not controlled within this study. The growth mindset intervention platform (Mindsetmaker) provides additional resources for the teachers to use, explore, and study outside of the five required modules. The additional resources include: (a) a community forum that fosters discussions among educators who also have the Mindsetmaker tool, (b) activities to do in class, and (c) assessments with feedback. The amount of time that each teacher in the mindset condition spent using these additional resources was not recorded and therefore was not considered during the data analyses. The time that teachers spent using these resources could make a difference when determining how the teachers embrace a growth mindset. Teachers who only complete the required five

modules, and did not partake in the use of the additional tools may not be as invested in fostering a growth mindset culture in their classroom.

An additional limitation derives from my observation of the students completing surveys. The sixth and seventh graders across several schools often asked what certain words meant, including: praise, intelligence, promote, initial, fascinated, challenge, and effort. The teachers and I would tell them what those words meant so that they could accurately answer the questions but this raises concern, because if some students were shamed to not speak up and did not know what certain words meant, then they may not have answered some questions accurately. Middle school students also struggled to answer demographic information like race and gender because many of them did not know what those constructs were. It is also important to note that IJHS had the lowest measures at Time 1 in nearly all of the motivation constructs (see tables 16 through 28). This may appear to be a low performing school but these findings may be a function of who had permission to be in the study. The principal and administration worked with me to have the entire IJHS student body and all of their math teachers participate in this study. All other teachers and students in this study participated because they individually wanted to be apart of it. Considering what findings can be generalized, IJHS estimates may most accurately represent most teachers and students instead of the teachers and students who wanted to be part of the study. The significant school differences found in the tables could say a lot about the motivation differences between students who are likely to participate versus students who are just doing what is put in front of them.

The eighth limitation was that the teachers were randomly assigned to the condition not the students. Since the intervention took place at the teacher level, the findings in research question one (teacher effects) will be based on small effect sizes (25 teachers) which has low

statistical power and may help explain the lack of significant results from research question one. However, small effect sizes can influence outcomes over time (Abelson, 1985) and the effect size at the student level was greater and allowed me to estimate significant findings. Also, the randomization at the teacher level should have been a controlled randomization, which would have ensured that I had a balanced number of condition group members at each school. Making this change could have led to more variation explained at the teacher level of the analysis models used in research questions two and three. This leads to the final limitation, which is that this study did not control for social desirability. Many teachers and students may have answered the questions in a specific way because they know it is the most accepted answer and therefore they may not have provided authentic answers. Thus, when completing the growth mindset measurement, many teachers may have self-endorsed themselves as having a perfect growth mindset orientation toward their work because they knew that the study was growth mindset related.

Significance of Study

The limitations section of this study suggests several items to consider in future research. One item to consider is to add a qualitative component that can contextualize and nuance the beliefs of the teachers. An additional qualitative component that helps the researcher to better understand how and when the participating teachers apply a growth mindset to their work, would also be beneficial. Finally, future studies should have more teachers as participants since randomization occurs at the teacher level.

Yet, despite these possible directions for future studies, this current study could have implications for both research and practice. Findings from this study begin to illustrate the important role of teachers and, in particular, teacher beliefs and practices from the effects of

growth mindset interventions on student motivation and achievement. Notably the findings from RQ3 indicate that student-rated teacher practice impact student motivation and that teacher mindset influences student mindset. Moreover, findings from this study should be used to inform teacher education and teacher professional development. From the results of this study I would encourage teachers and school administrators to invest their resources in having their teachers adopt a growth mindset in efforts to shift the teacher mindset practices, and the learning culture of their schools. This is an efficient approach for many schools, considering that access to teachers is more manageable than accessing the entire student body. Future studies building from this project could provide more evidence concerning what teacher beliefs moderate teacher practices.

Finally, influencing student achievement and motivation without addressing home environments, local politics, racial inequities, and school conditions is incomplete research and tells an incomplete story. By approaching this study with a focus on psychological factors, which are often interpreted as individual oriented, I am not denying the importance of the above-mentioned social systemic factors, and in this case I center teachers in the study, who are the socializers of the learning environment. Dweck and London (2004) share that social environmental conditions influence students psychologically. So it is important for researchers to explore students' "access to the both the power of culture and culture of power" (Salazar, 2003 pg. 145). The culture of power being a student's ability to use their own agency (e.g., growth mindset) to reach their goals and the power of culture which is a student's social circumstance which also impacts their pursuit of the goal. Both are important and neither should be ignored.

APPENDICES

APPENDIX A: Tables

Table 1

Student Demographics by Condition

N	Student			Teacher		
	Mindset	BAU	Total	Mindset	BAU	Total
<u>Sex</u>						
Male	303	541	844	3	5	8
Female	312	482	794	8	9	17
<u>Race/Ethnicity</u>						
Black	78	146	224	1	0	1
Asian	38	88	126	0	1	1
Latino	38	82	120	0	0	0
Ancillary	22	17	39	0	0	0
White	390	597	987	10	13	23
Multi-	49	85	13	0	0	0
<u>Racial School</u>						
FHS (2)	0	85	85	0	2	2
IJHS (8)	284	560	844	3	5	8
IMS (1)	0	51	51	0	1	1
MCA (3)	0	84	84	0	3	3
PHS (5)	117	177	294	3	2	5
SCMS (1)	0	73	73	0	1	1
MMMS (2)	94	0	94	2	0	2
IHS (2)	99	0	99	2	0	2
NHS (1)	29	0	29	1	0	1
<u>Grade Level</u>						
6 th	96	140	236	-	-	-
7 th	83	383	466	-	-	-
8 th	200	244	444	-	-	-
9 th	103	63	166	-	-	-
10 th	92	45	137	-	-	-
11 th	12	89	101	-	-	-
12 th	37	59	96	-	-	-
<u>Free Lunch</u>						
Yes	192	354	546	-	-	-
No	418	647	1065	-	-	-
<u>Years Teaching</u>						
More than 10	-	-	-	7	6	13
Less than 10	-	-	-	4	8	12

Note: BAU = Business as usual control condition. Value in Parenthesis, next to school, is the amount of participating teachers in that school.

Table 2

Students by Teachers by Condition

School	Teacher	Mindset	BAU
SCMS^r			
	Ms. Reed	-	73 (7%)
IJHS^s			
	Ms. Buffer	-	138 (13%)
	Ms. Knowles	-	129 (13%)
	Ms. Love	-	136 (13%)
	Mr. Grayson	-	134 (13%)
	Ms. Weigh	84 (13%)	-
	Ms. Royce	72 (12%)	-
	Ms. Wolfe	128 (21%)	-
	Mr. Bevinson*	-	22 (2%)
IMS^u			
	Ms. Taylor	-	51 (5%)
FHS^u			
	Ms. Rose	-	22 (2%)
	Mr. Greyjoy	-	63 (6%)
PHS^s			
	Ms. Quick	-	94 (9%)
	Mr. Viola	-	83 (8%)
	Ms. Hukstable	17 (3%)	-
	Mr. Mills	19 (3%)	-
	Ms. McMahon	81 (13%)	-
MCA^u			
	Ms. Olds	-	17 (2%)
	Ms. Pumkin*	-	30 (3%)
	Mr. Chan	-	37 (4%)
MNHS^u			
	Ms. Simpson	29 (5%)	-
IHS^s			
	Mr. Carter	55 (8%)	-
	Mr. Nelson	45 (7%)	-
MMMS^s			
	Ms. Fey	44 (7%)	-
	Ms. Poller	50 (8%)	-
Total		624 (38%)	1029 (62%)

Note: * Teacher originally assigned to mindset intervention (experimental) condition but did not complete nor start the intervention. BAU = Business as usual control condition. MS = Mindset intervention condition.

^r. School classified as rural school.

^s. School classified as suburban school.

^u. School classified as urban school.

Table 3

<i>Student Demographics Percentages by Condition</i>			
Demographic	Group	MS	BAU
<u>Race</u>			
	Black	13%	14%
	Asian	6%	9%
	Latino	6%	8%
	Ancillary	4%	2%
	White	63%	59%
	Multi-Racial	8%	8%
<u>Race Binary</u>			
	White & Asian	30%	33%
	URM & Multi	70%	67%
<u>Grade level</u>			
	6 th	15%	14%
	7 th	13%	37%
	8 th	32%	24%
	9 th	17%	6%
	10 th	15%	4%
	11 th	2%	9%
	12 th	6%	6%

Note: BAU = Business as usual control condition. MS = Mindset intervention condition. URM = Underrepresented minority ethnic groups.

Table 4

Reliability of Each Construct/Scale

	Time1		Time2	
	Teacher	Student	Teacher	Student
View of ability: Mindset (6)	.960	.833	.916	.851
Mastery approach (5)	-	.920	-	.934
Performance approach (5)	-	.928	-	.946
Performance avoidance (4)	-	.850	-	.892
Self efficacy in math (5)	.942	.911	.924	.925
Efficacy for instructional Practice (4)	.857	-	.812	-
Efficacy for student engagement (4)	.815	-	.892	-
Interest value (6)	-	.971	-	.974
Utility value (4)	-	.889	-	.913
Attainment value (6)	-	.917	-	.923
Effort cost (5)	-	.914	-	.940
Teacher mastery orientation (5)	-	.814	-	.854
Teacher practices				
Teachers	.771 ^a	-	.743 ^a	-
Students	-	.613 ^b	-	.656 ^b
Student engagement (5)	-	.856	-	.884
Teacher work avoidance (3)	.858	-	.924	-

Note: Each Dependent Variable in the study with amount of items in parenthesis. Data derived from Time 1.

Teachers have 6 constructs for 26 items and students have 12 constructs for 59 items.

^a. Item #1 removed to increase reliability. Reported value represents 4 items.

^b. Item #1 & item #4 removed to increase reliability. Reported value represents 3 items.

Table 5

Research Questions, Variables, and Analyses.

Research question / Data analysis	Dependent variables
RQ1: How does teacher participation in the growth mindset intervention affect TEACHERS? (Repeated measures ANCOVA)	○ Teacher view of ability (Dweck, 2007) ○ Self efficacy in Math (PALS, 2000) ○ Efficacy for instructional practices (Tschannen-Moran, & Hoy, 2001) ○ Efficacy for student engagement (Tschannen-Moran, & Hoy, 2001) ○ Teacher mindset practices (created for this study) ○ Teacher work avoidance (Harackiewicz et al., 2008)
RQ2: How does teacher participation in the growth mindset intervention affect STUDENTS? RQ2.5: Differential effects based on race/ethnicity? (Hierarchical Linear Models, HLM)	○ Student View of Ability (Dweck, 2007) ○ Mastery Goal Orientation (PALS, 2000) ○ Performance Approach Orientation (PALS, 2000) ○ Performance Avoidance Orientation (PALS, 2000) ○ Self efficacy in Math (PALS, 2000) ○ Interest (Conley, 2012) ○ Utility (Conley, 2012) ○ Attainment (Conley, 2012) ○ Cost (effort, Flake et al. 2015) ○ Behavioral Engagement (Skinner et al., 2008) ○ Student perception of teacher mastery (PALS, 2000) ○ Teacher mindset practices (created for this study)
RQ3: Do teacher beliefs moderate the effect of the intervention on student motivation and achievement? (HLM)	○ Same dependent variables as RQ2. ○ Dependent variables from RQ1 are used as moderators. ○ Teacher mindset practices (teacher responses).

Note. The predictor groups for all research questions are teachers who participated in the growth mindset online program and the business as usual control group who did not participate.

Table 6

Summary of Exploratory Factor Analysis (EFA) Results for the Teacher Practice Scale Time 1

	Teacher (KMO = .689)		Student (KMO = .669)	
	N = 25		N = 774	
	Factor 1	Factor 2	Factor 1	Factor 2
(1) How often does your math teacher praise you for your intelligence?	-.010	.562	-.753	-.069
(2) How often does your math teacher praise you for your effort?	.639	-.305	.857	.008
(3) How often does your math teacher present challenging tasks as exciting?	.869	.283	.548	.194
(4) How often does your math teacher present easy tasks as boring?	.574	-.004	.016	-.198
(5) How often does your math teacher promote challenging work over successful work?	.674	-.042	.366	.742
Eigenvalues	2.375	1.1	2.183	1.09
% of variance	47.51	22	43.66	21.82

Note: Factor loadings over .40 appear in bold

Table 7

Summary of Exploratory Factor Analysis (EFA) Results for the Teacher Practice Scale Time 2

	Teacher (KMO = .715)		Student (KMO = .655)	
	N = 25		N = 651	
	Factor 1	Factor 2	Factor 1	Factor 2
(1) How often does your math teacher praise you for your intelligence?	-.098	.349	-.791	-.014
(2) How often does your math teacher praise you for your effort?	.488	-.836	.794	.073
(3) How often does your math teacher present challenging tasks as exciting?	.798	-.433	.644	.223
(4) How often does your math teacher present easy tasks as boring?	.687	-.443	.040	.835
(5) How often does your math teacher promote challenging work over successful work?	.661	-.111	.415	-.128
Eigenvalues	2.43	1.1	2.32	1.11
% of variance	48.57	21.25	46.39	22.82

Note: Factor loadings over .40 appear in bold

Table 8

Summary of Exploratory Factor Analysis (EFA) Results for the Teacher Practice Scale Completed by Students

	Time1 (KMO = .577) N = 774		Time2 (KMO = .552) N = 651	
	Factor 1	Factor 2	Factor 1	Factor 2
(2) How often does your math teacher praise you for your effort?	.576	-.044	.550	.078
(3) How often does your math teacher present challenging tasks as exciting?	.780	-.012	.846	.301
(4) How often does your math teacher present easy tasks as boring?	.011	.422	.073	.578
(5) How often does your math teacher promote challenging work over successful work?	.425	-.414	.534	-.278
Eigenvalues	1.67	1.08	1.78	1.11
% of variance	41.70	26.96	44.37	27.83

Note: Factor loadings over .40 appear in bold

Table 9

Loadings for one factor confirmatory model of teacher practices

	Estimate (SE)	
	Time 1 N = 774	Time 2 N = 649
(2) How often does your math teacher praise you for your effort?	1.03** (.09)	1.06** (.09)
(3) How often does your math teacher present challenging tasks as exciting?	1.45** (.10)	1.33** (.10)
(4) How often does your math teacher present easy tasks as boring?	.26** (.08)	.11 (.08)
(5) How often does your math teacher promote challenging work over successful work?	.90** (.08)	.87** (.08)

Note: ** $p < .001$.

Table 10

Fit Statistics for Confirmatory Factor Analysis (CFA) of Teacher Practices

Measurement Invariance	χ^2	<i>df</i>	CFI	TLI	RMSEA
Teacher Practice Time 1 N = 774	55.82**	2	.838	.515	.146
Teacher Practice Time 2 N = 649	27.196**	2	.924	.772	.096

Note. CFI = comparative fit index; TLI = Tucker and Lewis Index; RMSEA = root-mean-square error of approximation. ** $p < .001$. Both CFA were conducted for a single factor.

Table 11

Bivariate Correlations for Teachers

		Time 2					
		1	2	3	4	5	6
Time 1	1. GMS	.80**	.34	.16	.29	-.15	.47*
	2. Competence	.39	.48*	.58**	.52**	-.60**	.67**
	3. T.E. Instruct	.37	.37	.64**	.55**	-.52**	.56**
	4. T.E. Stu. Eng.	.71**	.49*	.56**	.45*	-.24	.50*
	5. Work Avoid	-.07	-.33	-.20	-.18	.62**	-.56*
	6. Teacher Pract.	.50*	.31	.46*	.62**	-.37	.62**

Note. GMS = Growth Mindset/view of ability. Competence = math efficacy. T.E. Instruct = Teacher efficacy in instruction. T.E. Stu. Eng. = Teacher efficacy in student engagement. Teacher pract = teacher practices. Work Av. = Work avoidance. * Correlation is significant at the .05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). Bottom half of table shows correlations among Time 1 variables; top half shows correlations among Time 2 variables. Bolded correlations along the diagonal are correlations for the same construct at Time 1 and Time 2.

Table 12

Bivariate Correlations for Students

		Time 2											
		1	2	3	4	5	6	7	8	9	10	11	12
Time 1	1. GMS	.61**	.31**	.22**	.19**	.21**	.20**	-.25**	.26**	-.08**	-.07*	.26**	.09**
	2. Competence	.28**	.63**	.39**	.51**	.50**	.58**	-.35**	.58**	.24**	.16**	.52**	.22**
	3. PTMastery	.18**	.39**	.63**	.35**	.31**	.33**	-.40**	.42**	.10**	.03	.37**	.61**
	4. Interest	.18**	.55**	.33**	.79**	.46**	.60**	-.40**	.45**	.16**	.08**	.40**	.25**
	5. Utility	.15**	.44**	.27**	.45**	.62**	.62**	-.30**	.55**	.15**	.07**	.38**	.20**
	6. Attainment	.17**	.60**	.34**	.65**	.65**	.67**	-.29**	.61**	.40**	.30**	.44**	.25**
	7. Cost	-.21**	-.37**	-.33**	-.40**	-.25**	-.30**	.60**	-.31**	.05	.07*	-.26**	-.18**
	8. Mastery	.22**	.57**	.37**	.48*	.55**	.66**	-.30**	.60**	.23**	.17**	.58**	.29**
	9. PAP	-.07**	.24**	.11**	.17**	.14**	.35**	.06*	.26**	.61**	.67**	.19**	.13**
	10. PAV	-.05*	.10**	.01	.03	.07**	.21**	.08**	.14**	.58**	.54**	.15**	.06*
	11. Beh. Eng.	.15**	.53**	.39**	.42**	.35**	.48**	-.29**	.55**	.21**	.10**	.59**	.28**
	12. Teacher pract.	.09**	.26**	.55**	.22**	.18**	.25**	-.16**	.27**	.12**	.01*	.27**	.52**

Note. GMS = Growth Mindset/view of ability. Competence = math efficacy. PTMastery = perceived teacher mastery. Interest = interest value. Utility = utility value. Attainment = attainment value. Cost = effort cost value. Mastery = mastery orientation. PAP = performance approach orientation. PAV = performance avoidance orientation. Beh. Eng. = behavioral engagement. Teacher pract = teacher practices. * Correlation is significant at the .05 level (2-tailed). ** Correlation is significant at the .01 level (2-tailed). Bottom half of table shows correlations among Time 1 variables; top half shows correlations among Time 2 variables. Bolded correlations along the diagonal are correlations for the same construct at Time 1 and Time 2.

Table 13

Descriptive Statistics for Teachers

Group	Mindset (N = 11)		BAU (N = 14)	
Time	1	2	1	2
	M (SD)	M (SD)	M (SD)	M (SD)
1. GMS	5.88 (.85)	6.11 (.65)	6.06 (.96)	5.99(1.1)
2. Competence	6.18 (.94)	6.38 (.53)	6.54 (.65)	6.34(.58)
3. T.E. Instruct	4.91 (.73)	5.27 (.68)	5.11 (.86)	5.52(.87)
4. T.E. Stu. Eng.	4.84 (.77)	5.14 (.92)	5.09 (.74)	5.07(.82)
5. Work Avoid	1.55 (.60)	1.30 (.57)	1.59 (.74)	1.60(.93)
6. Teacher Pract.	5.32 (.92)	5.25 (.71)	5.32 (.96)	5.52(.87)

Note. GMS = Growth Mindset/view of ability. Competence = math efficacy. T.E. Instruct = Teacher efficacy in instruction. T.E. Stu. Eng. = Teacher efficacy in student engagement. Teacher pract = teacher practices. Work Av. = Work avoidance.

Table 14

Descriptive Statistics for Students

Group	Mindset		BAU	
Time	1	2	1	2
	N = 577	N = 460	N = 971	N = 840
	M (SD)	M (SD)	M (SD)	M (SD)
1. GMS	5.11 (1.24)	5.12 (1.25)	5.12 (1.18)	5.07 (1.18)
2. Competence	5.01 (1.42)	5.10 (1.38)	5.20 (1.33)	5.12 (1.36)
3. PTMastery	5.31 (1.17)	4.98 (1.35)	5.32 (1.15)	5.10 (1.3)
4. Interest	3.54 (1.93)	3.80 (1.84)	3.91 (1.95)	3.84 (1.91)
5. Utility	5.29 (1.47)	5.23 (1.56)	5.59 (1.32)	5.41 (1.4)
6. Attainment	4.42 (1.46)	4.32 (1.43)	4.69 (1.37)	4.56 (1.41)
7. Cost	3.50 (1.63)	3.53 (1.76)	3.42 (1.59)	3.63 (1.63)
8. Mastery	5.50 (1.3)	5.31 (1.38)	5.73 (1.14)	5.40 (1.29)
9. PAP	3.60 (1.66)	3.46 (1.72)	3.62 (1.72)	3.63 (1.72)
10. PAV	4.15 (1.63)	3.94 (1.67)	4.17 (1.65)	4.12 (1.67)
11. Beh. Eng.	5.19 (1.2)	5.03 (1.28)	5.28 (1.18)	5.13 (1.22)
12. Teacher pract.	4.27 (1.38)	4.21 (1.39)	4.40 (1.35)	4.22 (1.39)

Note. GMS = Growth Mindset/view of ability. Competence = math efficacy. PTMastery = perceived teacher mastery. Interest = interest value. Utility = utility value. Attainment = attainment value. Cost = effort cost value. Mastery = mastery orientation. PAP = performance approach orientation. PAV = performance avoidance orientation. Beh. Eng. = behavioral engagement. Teacher pract = teacher practice. BAU = Business as usual control group.

Table 15

Covariate Analysis: Teacher Mindset Intervention Predicting Teacher Beliefs and Practice

	F	Eta Sq.	Mean	C.I.	Mean	C.I.
Time			Time 1	Time 1	Time 2	Time 2
GMS	0.13	0.01	5.81	5.27, 6.35	6.12	5.54, 6.68
Math Eff.	0.49	0.03	6.4	5.81, 7.00	6.31	5.90, 6.71
TE Instr.	2.43	0.12	4.78	4.26, 5.30	5.10	4.57, 5.63
TE Student Engagement	0.10	0.01	4.69	4.17, 5.20	4.96	4.30, 5.62
Work Avoid.	10.01**	0.36	1.63	1.17, 2.09	1.79	1.45, 2.14
T. Practice (Stu)	3.22	0.15	4.27	3.99, 4.55	4.34	4.04, 4.65
T. Practice (Tea)	0.28	0.02	5.17	4.50, 5.85	5.15	4.61, 5.70
Intervention			Mindset	Mindset	BAU	BAU
GMS	0.11	0.01	5.90	5.24, 6.57	6.02	5.42, 6.62
Math Eff.	0.75	0.04	6.23	5.66, 6.79	6.48	5.97, 6.99
TE Instr.	2.60	0.13	4.67	4.08, 5.29	5.19	4.65, 5.74
TE Student Engagement	0.07	.00	4.78	4.13, 5.42	4.87	4.28, 5.25
Work Avoid.	0.34	0.02	1.78	1.32, 2.24	1.64	1.22, 2.06
T. Practice (Stu)	2.82	0.14	4.15	3.81, 4.50	4.45	4.15, 4.76
T. Practice (Tea)	0.95	0.05	4.98	4.27, 5.69	5.34	4.70, 5.98
Time*Intervention			T1 Mindset	T1 Mindset	T1 BAU	T1 BAU
GMS	0.38	0.02	5.72	5.02, 6.41	5.91	5.28, 6.54
Math Eff.	1.36	0.07	6.17	5.42, 6.93	6.62	5.94, 7.31
TE Instr.	0.01	.00	4.53	3.86, 5.20	5.03	4.43, 5.63
TE Student Engagement	0.37	0.02	4.58	3.92, 5.24	4.79	4.19, 5.39
Work Avoid.	0.06	.00	1.68	1.09, 2.27	1.57	1.04, 2.10
T. Practice (Stu)	1.21	0.06	4.08	3.71, 4.43	4.46	4.13, 4.79
T. Practice (Tea)	1.83	0.09	4.86	4.82, 6.09	5.23	4.45, 6.01
			T2 Mindset	T2 Mindset	T2 BAU	T2 BAU
GMS	0.38	0.02	6.09	5.36, 6.81	6.13	5.47, 6.78
Math Eff.	1.36	0.07	6.28	5.76, 6.80	6.34	5.87, 6.81
TE Instr.	0.01	.00	4.84	4.17, 5.51	5.36	4.75, 5.97
TE Student Engagement	0.37	0.02	4.98	4.13, 5.82	4.94	4.18, 5.70
Work Avoid.	0.06	.00	1.88	1.44, 2.32	1.71	1.31, 2.10
T. Practice (Stu)	1.21	0.06	4.27	3.85, 4.63	4.45	4.09, 4.80
T. Practice (Tea)	1.83	0.09	4.87	4.15, 5.56	5.45	4.82, 6.08

Note: The covariate in the model, teacher prior familiarity with growth mindset literature, is held at a constant of 5.04. Binary categorical factors in the model include gender, years teaching, and two school dummy variables. Degrees of freedom are (1, 18) for the MANCOVA model. BAU = Business as usual control condition, GMS = growth mindset, TE = teacher efficacy, and Eng. = Engagement, Practice (Stu) = student responses to measure, and T. Practice (Tea) = teacher responses to measure. *p < .05. p **<.01.

Table 16

Covariate Analysis: Teacher Mindset Intervention on Student Growth Mindset

Model ^a	Growth mindset	
	1	2
Omnibus ^b	517.03**	515.75**
Fixed effects		
Intercept, β_0	5.19** (.10)	5.19** (.10)
Time, β_1	-.06 (.04)	-.06 (.04)
Intervention, β_2	-.09 (.09)	-.09 (.09)
Race, β_3	-.13* (.06)	-.13* (.07)
Gender, β_4	-.03 (.06)	-.03 (.06)
School, β_5		
FHS, β_6	.31 (.21)	.31 (.22)
IHS, β_7	.48** (.17)	.48** (.17)
IMS, β_8	.64** (.19)	.64** (.19)
MCA, β_9	-.03 (.16)	-.03 (.16)
NHS, β_{10}	.33 (.27)	.33 (.27)
PHS, β_{11}	.06 (.15)	.06 (.16)
SCMS, β_{12}	-.40* (.17)	-.40* (.17)
MMMS, β_{13}	.00 (.16)	.00 (.17)
Free Lunch, β_{14}	.04 (.06)	.04 (.06)
Grade Level, β_{15}	-.04 (.04)	-.04 (.04)
Time X Intervention, β_{16}	.09 (.06)	.09 (.07)
Time X Intervention X Race, β_{17}		.02 (.11)
Random effects		
Teacher	.00 (.01)	.01 (.01)
Student	.86** (.05)	.86** (.05)
Residual	.57** (.02)	.58** (.02)
-2LL	8337.3	8339.8

Note: Students in the free or reduced lunch program are the reference group. Grade level is a continuous variable. IJHS is the reference group for school.

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 17

Covariate Analysis: Teacher Mindset Intervention on Students' Perceptions of Teacher Mastery

Model ^a	Perceptions of teacher mastery	
	1	2
Omnibus ^b	597.46**	597.05**
Fixed effects		
Intercept, β_0	5.11** (.18)	5.11** (.19)
Time, β_1	-.24** (.04)	-.24** (.04)
Intervention, β_2	-.07 (.23)	-.07 (.23)
Race, β_3	.10 (.06)	.11 (.06)
Gender, β_4	.04 (.05)	.04 (.05)
School, β_5		
FHS, β_6	.21 (.38)	.21 (.38)
IHS, β_7	.69 (.36)	.69 (.36)
IMS, β_8	.87* (.44)	.87* (.44)
MCA, β_9	.83** (.30)	.83** (.30)
NHS, β_{10}	.67 (.49)	.67 (.49)
PHS, β_{11}	.73** (.28)	.73** (.28)
SCMS, β_{12}	.58 (.43)	.58 (.43)
MMMS, β_{13}	.68 (.36)	.68 (.36)
Free Lunch, β_{14}	-.10 (.06)	-.10 (.06)
Grade Level, β_{15}	-.04 (.05)	-.04 (.05)
Time X Intervention, β_{16}	-.03 (.06)	-.02 (.08)
Time X Intervention X Race, β_{17}		-.04 (.11)
Random effects		
Teacher	.14** (.06)	.14** (.06)
Student	.73** (.04)	
Residual	.58** (.02)	.58** (.02)
-2LL	8165.5	8189

Note:

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 18

Covariate Analysis: Teacher Mindset Intervention on Teacher Practices (Student Responses)

Model ^a	Teacher practices	
	1	2
Omnibus ^b	375.59**	375.85**
Fixed effects		
Intercept, β_0	4.36** (.19)	4.34** (.19)
Time, β_1	-.16** (.05)	-.11** (.04)
Intervention, β_2	-.20 (.22)	-.15 (.22)
Race, β_3	.18** (.07)	.17* (.07)
Gender, β_4	.02 (.06)	.02 (.06)
School, β_5		
FHS, β_6	.43 (.37)	.43 (.37)
IHS, β_7	.62 (.35)	.62 (.35)
IMS, β_8	.57 (.43)	.57 (.43)
MCA, β_9	.82** (.30)	.83** (.30)
NHS, β_{10}	.31 (.47)	.29 (.49)
PHS, β_{11}	.73** (.28)	.74** (.28)
SCMS, β_{12}	.46 (.41)	.45 (.42)
MMMS, β_{13}	.76* (.35)	.76* (.35)
Free Lunch, β_{14}	-.18** (.06)	-.18** (.07)
Grade Level, β_{15}	-.09 (.06)	-.09 (.06)
Time X Intervention, β_{16}	.11 (.08)	.08 (.09)
Time X Intervention X Race, β_{17}		.12 (.13)
Random effects		
Teacher	.12* (.05)	.12* (.05)
Student	.79** (.05)	.79** (.05)
Residual	.92** (.04)	.92** (.04)
-2LL	9046.5	9047.9

Note:

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 19

Covariate Analysis: Teacher Mindset Intervention on Student Interest in Math

Model ^a	Interest	
	1	2
Omnibus ^b	1060.24**	1057.80**
Fixed effects		
Intercept, β_0	3.99** (.20)	4.00** (.20)
Time, β_1	-.08 (.04)	-.09 (.04)
Intervention, β_2	-.20 (.20)	-.20 (.20)
Race, β_3	-.26** (.10)	-.29** (.10)
Gender, β_4	-.29** (.09)	-.29** (.09)
School, β_5		
FHS, β_6	1.01** (.41)	1.02* (.41)
IHS, β_7	.03 (.35)	.04 (.35)
IMS, β_8	.62 (.41)	.63 (.41)
MCA, β_9	1.81** (.30)	1.82** (.30)
NHS, β_{10}	1.95** (.51)	1.92** (.51)
PHS, β_{11}	.99** (.30)	1.00** (.30)
SCMS, β_{12}	.44 (.38)	.44 (.38)
MMMS, β_{13}	.61 (.33)	.62 (.34)
Free Lunch, β_{14}	-.06 (.10)	-.06 (.10)
Grade Level, β_{15}	-.14 (.08)	-.14 (.08)
Time X Intervention, β_{16}	.25** (.08)	.20* (.08)
Time X Intervention X Race, β_{17}		.21 (.13)
Random effects		
Teacher	.07 (.05)	.07 (.05)
Student	2.63** (.11)	2.63** (.11)
Residual	.76** (.03)	.76** (.03)
-2LL	10094.9	10094.6

Note:

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 20

Covariate Analysis: Teacher Mindset Intervention on Student Utility in Math

Model ^a	Utility	
	1	2
Omnibus ^b	544.53**	543.31**
Fixed effects		
Intercept, β_0	5.86** (.17)	5.87** (.17)
Time, β_1	-.22** (.04)	-.22** (.04)
Intervention, β_2	-.34 (.18)	-.34 (.18)
Race, β_3	-.15* (.07)	-.18* (.07)
Gender, β_4	-.03 (.06)	-.04 (.06)
School, β_5		
FHS, β_6	.03 (.34)	.04 (.34)
IHS, β_7	.06 (.31)	.06 (.31)
IMS, β_8	.10 (.37)	.10 (.37)
MCA, β_9	.57* (.26)	.58* (.26)
NHS, β_{10}	.78 (.44)	.76 (.44)
PHS, β_{11}	.24 (.25)	.24 (.25)
SCMS, β_{12}	.17 (.35)	.17 (.35)
MMMS, β_{13}	.37 (.30)	.38 (.30)
Free Lunch, β_{14}	-.08 (.08)	-.08 (.08)
Grade Level, β_{15}	-.11 (.06)	-.12 (.06)
Time X Intervention, β_{16}	.10 (.07)	.06 (.08)
Time X Intervention X Race, β_{17}		.17 (.13)
Random effects		
Teacher	.08* (.04)	.08* (.04)
Student	1.17** (.06)	1.16** (.06)
Residual	.75** (.03)	.75** (.03)
-2LL	9075.3	9075.7

Note:^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 21

Covariate Analysis: Teacher Mindset Intervention on Student Attainment value (importance) of Math

Model ^a	Attainment value	
	1	2
Omnibus ^b	651.89**	650.19**
Fixed effects		
Intercept, β_0	4.99** (.15)	4.99** (.15)
Time, β_1	-.15** (.04)	-.15** (.04)
Intervention, β_2	-.15 (.14)	-.15 (.15)
Race, β_3	-.14 (.07)	-.16* (.08)
Gender, β_4	-.14* (.07)	-.14* (.07)
School, β_5		
FHS, β_6	.80** (.30)	.80** (.30)
IHS, β_7	.26 (.25)	.26 (.25)
IMS, β_8	-.05 (.30)	-.05 (.30)
MCA, β_9	.87** (.22)	.88** (.22)
NHS, β_{10}	1.15** (.38)	1.13** (.38)
PHS, β_{11}	.82** (.22)	.82** (.22)
SCMS, β_{12}	.16 (.27)	.15 (.27)
MMMS, β_{13}	.03 (.25)	.04 (.25)
Free Lunch, β_{14}	-.03 (.08)	-.03 (.08)
Grade Level, β_{15}	-.22** (.06)	-.22** (.06)
Time X Intervention, β_{16}	-.03 (.07)	-.07 (.07)
Time X Intervention X Race, β_{17}		.14 (.12)
Random effects		
Teacher	.04 (.02)	.04 (.02)
Student	1.27** (.06)	1.26** (.06)
Residual	.64** (.03)	.64** (.03)
-2LL	8913.2	8914.1

Note:

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 22

Covariate Analysis: Teacher Mindset Intervention on Student Cost (of effort) in Math

Model ^a	Cost	
	1	2
Omnibus ^b	519.09**	518.73**
Fixed effects		
Intercept, β_0	3.79** (.26)	3.77* (.26)
Time, β_1	.19** (.05)	.19** (.05)
Intervention, β_2	.16 (.32)	.16 (.32)
Race, β_3	.16 (.08)	.20* (.09)
Gender, β_4	.05 (.07)	.05 (.07)
School, β_5		
FHS, β_6	.39 (.52)	.38 (.52)
IHS, β_7	-.53 (.50)	-.54 (.50)
IMS, β_8	-1.08 (.61)	-1.08 (.61)
MCA, β_9	-.56 (.42)	-.57 (.42)
NHS, β_{10}	-.63 (.68)	-.59 (.68)
PHS, β_{11}	-.09 (.38)	-.09 (.38)
SCMS, β_{12}	-.77 (.60)	-.77 (.60)
MMMS, β_{13}	-.93 (.50)	-.95 (.50)
Free Lunch, β_{14}	-.17* (.09)	-.18* (.09)
Grade Level, β_{15}	-.09 (.07)	-.09 (.07)
Time X Intervention, β_{16}	-.16 (.09)	-.09 (.10)
Time X Intervention X Race, β_{17}		-.30* (.15)
Random effects		
Teacher	.27* (.12)	.27* (.12)
Student	1.40** (.08)	1.40** (.08)
Residual	1.08** (.04)	1.08** (.04)
-2LL	9879	9877

Note:

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 23

Covariate Analysis: Teacher Mindset Intervention on Student Mastery Orientation in Math

Model ^a	Mastery	
	1	2
Omnibus ^b	461.22**	460.63**
Fixed effects		
Intercept, β_0	5.73** (.13)	5.74** (.14)
Time, β_1	-.37** (.04)	-.37** (.04)
Intervention, β_2	-.16 (.14)	-.16 (.15)
Race, β_3	-.03 (.07)	-.06 (.07)
Gender, β_4	.18** (.06)	.18** (.06)
School, β_5		
FHS, β_6	.49 (.28)	.51 (.28)
IHS, β_7	.14 (.25)	.15 (.25)
IMS, β_8	.19 (.29)	.19 (.29)
MCA, β_9	.75** (.21)	.76** (.21)
NHS, β_{10}	.77* (.35)	.75* (.36)
PHS, β_{11}	.44* (.21)	.44* (.21)
SCMS, β_{12}	.16* (.27)	.15 (.27)
MMMS, β_{13}	.11 (.24)	.12 (.24)
Free Lunch, β_{14}	-.04 (.06)	-.04 (.07)
Grade Level, β_{15}	-.11* (.05)	-.12* (.05)
Time X Intervention, β_{16}	.15* (.07)	.10 (.07)
Time X Intervention X Race, β_{17}		.20 (.11)
Random effects		
Teacher	.04* (.02)	.04* (.02)
Student	.89** (.05)	.89** (.05)
Residual	.63** (.03)	.63** (.03)
-2LL	8448.3	8447.8

Note:

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 24

Covariate Analysis: Teacher Mindset Intervention on Student Performance Approach Orientation in Math

Model ^a	Performance approach	
	1	2
Omnibus ^b	504.18**	503.18**
Fixed effects		
Intercept, β_0	3.97** (.15)	3.97** (.15)
Time, β_1	-.02 (.05)	-.02 (.05)
Intervention, β_2	.15 (.14)	.15 (.14)
Race, β_3	-.03 (.09)	-.03 (.09)
Gender, β_4	.06 (.07)	.06 (.08)
School, β_5		
FHS, β_6	.48 (.32)	.48 (.32)
IHS, β_7	.53* (.26)	.53* (.26)
IMS, β_8	-.32 (.30)	-.31 (.30)
MCA, β_9	.57** (.23)	.58* (.23)
NHS, β_{10}	.01 (.39)	.00 (.40)
PHS, β_{11}	.80** (.23)	.80** (.23)
SCMS, β_{12}	.41 (.27)	.40 (.27)
MMMS, β_{13}	-.89** (.25)	-.89** (.25)
Free Lunch, β_{14}	-.24** (.09)	-.24** (.09)
Grade Level, β_{15}	-.21** (.06)	-.21** (.06)
Time X Intervention, β_{16}	-.11 (.09)	-.12 (.10)
Time X Intervention X Race, β_{17}		.07 (.15)
Random effects		
Teacher	.02 (.02)	.02 (.02)
Student	1.70** (.09)	1.70** (.09)
Residual	1.14** (.05)	1.14** (.05)
-2LL	10092.4	10094.1

Note:

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 25

Covariate Analysis: Teacher Mindset Intervention on Student Performance Avoidance Orientation in Math

Model ^a	Performance avoidance	
	1	2
Omnibus ^b	393.17**	390.71**
Fixed effects		
Intercept, β_0	4.50** (.14)	4.51** (.14)
Time, β_1	-.08 (.05)	.08 (.06)
Intervention, β_2	.02 (.11)	.02 (.12)
Race, β_3	-.10 (.08)	-.14 (.09)
Gender, β_4	.08 (.08)	.08 (.07)
School, β_5		
FHS, β_6	-.23 (.28)	-.22 (.28)
IHS, β_7	.14 (.22)	.16 (.23)
IMS, β_8	-.13 (.26)	-.13 (.26)
MCA, β_9	.01 (.20)	.03 (.21)
NHS, β_{10}	-.13 (.35)	-.17 (.36)
PHS, β_{11}	.35 (.20)	.35 (.20)
SCMS, β_{12}	.36 (.22)	.36 (.22)
MMMS, β_{13}	-.57** (.22)	-.57** (.22)
Free Lunch, β_{14}	-.27** (.08)	-.27** (.09)
Grade Level, β_{15}	-.09 (.05)	-.09 (.06)
Time X Intervention, β_{16}	-.08 (.09)	-.15 (.10)
Time X Intervention X Race, β_{17}		.25 (.16)
Random effects		
Teacher	.01 (.01)	.01 (.01)
Student	1.46** (.09)	1.46** (.09)
Residual	1.23** (.05)	1.23** (.05)
-2LL	10054.8	10054.1

Note:

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 26

Covariate Analysis: Teacher Mindset Intervention on Student Efficacy in Math

Model ^a	Math efficacy	
	1	2
Omnibus ^b	555.78**	554.82**
Fixed effects		
Intercept, β_0	5.19** (.15)	5.20** (.15)
Time, β_1	-.08* (.04)	-.08* (.04)
Intervention, β_2	-.11 (.15)	-.11 (.15)
Race, β_3	.01 (.07)	-.01 (.07)
Gender, β_4	-.17** (.06)	-.17** (.06)
School, β_5		
FHS, β_6	.19 (.30)	.21 (.30)
IHS, β_7	.22 (.26)	.23 (.26)
IMS, β_8	.47 (.31)	.47 (.31)
MCA, β_9	1.02** (.23)	1.03** (.23)
NHS, β_{10}	.76* (.37)	.75* (.38)
PHS, β_{11}	.34 (.22)	.34 (.22)
SCMS, β_{12}	.38 (.29)	.38 (.29)
MMMS, β_{13}	.45 (.25)	.45 (.25)
Free Lunch, β_{14}	.01 (.07)	.01 (.07)
Grade Level, β_{15}	-.05 (.06)	-.05 (.06)
Time X Intervention, β_{16}	.06 (.07)	.03 (.07)
Time X Intervention X Race, β_{17}		.12 (.11)
Random effects		
Teacher	.05* (.03)	.05* (.03)
Student	1.10** (.06)	1.10** (.06)
Residual	.67** (.03)	.67** (.03)
-2LL	8729.3	8730.7

Note:

^a Models 1 and 2 are the same except Model 2 has a three way interaction. ^b Omnibus χ^2 (2).

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

Table 27

Covariate Analysis: Teacher Mindset Intervention on Student Behavioral Engagement in Math

Model ^a	Behavioral engagement	
	1	2
Omnibus ^b	463.11**	462.81**
Fixed effects		
Intercept, β_0	5.08** (.15)	5.08** (.15)
Time, β_1	-.15** (.01)	-.15** (.04)
Intervention, β_2	.02 (.17)	.02 (.17)
Race, β_3	.00 (.06)	-.01 (.06)
Gender, β_4	.15** (.05)	.15** (.05)
School, β_5		
FHS, β_6	.42 (.31)	.42 (.31)
IHS, β_7	.19 (.28)	.19 (.28)
IMS, β_8	.13 (.34)	.13 (.34)
MCA, β_9	.63** (.24)	.63** (.24)
NHS, β_{10}	.76 (.39)	.76 (.39)
PHS, β_{11}	.30 (.23)	.29 (.23)
SCMS, β_{12}	.65* (.33)	.65* (.32)
MMMS, β_{13}	.16 (.28)	.17 (.28)
Free Lunch, β_{14}	.11 (.06)	.11 (.06)
Grade Level, β_{15}	-.06 (.05)	-.06 (.05)
Time X Intervention, β_{16}	-.02 (.07)	-.04 (.07)
Time X Intervention X Race, β_{17}		.05 (.11)
Random effects		
Teacher	.07* (.04)	.07* (.04)
Student	.79** (.04)	.79** (.04)
Residual	.60** (.03)	.60** (.03)
-2LL	8196	8198.3

Note:

^a Models 1 and 2 are the same except Model 2 has a three-way interaction. ^b Omnibus χ^2 (2).

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

Table 28

Covariate Analysis: Teacher Mindset Intervention on Student Achievement in Math

Model ^a	Achievement	
	1	2
Omnibus ^b	238.83**	230.10**
Fixed effects		
Intercept, β_0	213.27** (3.44)	213.23** (3.43)
Time, β_1	6.46** (.56)	6.46** (.56)
Intervention, β_2	5.30 (4.28)	5.30 (4.26)
Race, β_3	-.93 (2.14)	-.78 (2.17)
Gender, β_4	-3.27* (1.47)	-3.28* (1.47)
Free Lunch, β_{14}	4.08* (1.74)	4.10* (1.75)
Grade Level, β_{15}	-15.15 (10.10)	-15.16 (10.10)
Time X Intervention, β_{16}	-2.08* (.86)	-1.96* (.90)
Time X Intervention X Race, β_{17}		-.79 (1.81)
Random effects		
Teacher	15.85 (17.94)	15.72 (17.84)
Student	92.57** (10.46)	92.26** (10.46)
Residual	14.43** (1.63)	14.55** (1.66)
-2LL	2394.3	2420.6

Note: Data includes responses from only four teachers (all sixth grade teachers) at three different schools, including: Ms. Reed, Ms. Taylor, Ms. Fey, and Ms. Poller.

^a Models 1 and 2 are the same except Model 1 has one interaction and Model 2 has two interactions. ^b

Omnibus χ^2 (2).

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

Table 29

Covariate Analysis: Teacher Mindset Intervention Predicting Student Motivation with Moderating Teacher Variables

	Interest	Mastery	GMS
Omnibus ^a	1037.29**	439.93**	509.77**
Fixed effects			
Intercept, β_0	4.04 (.26)	5.93** (.17)	5.40** (.13)
Time, β_1	-.09 (.04)	-.37** (.04)	-.06** (.04)
Intervention, β_2	-.26 (.20)	-.11 (.13)	.00 (.08)
Race, β_3	-.27** (.10)	-.03 (.06)	-.12 (.06)
Gender, β_4	-.28** (.09)	.18** (.06)	-.03 (.06)
School, β_5			
FHS, β_6	1.02* (.40)	.48 (.27)	.22 (.20)
IHS, β_7	.14 (.38)	.00 (.26)	.17 (.18)
IMS, β_8	.76 (.42)	.44 (.28)	.74* (.19)
MCA, β_9	1.81** (.36)	.93** (.24)	.06 (.18)
NHS, β_{10}	2.17** (.51)	.98** (.33)	.39 (.26)
PHS, β_{11}	.92** (.30)	.39 (.20)	.01 (.15)
SCMS, β_{12}	.57 (.40)	.42 (.27)	-.29 (.17)
MMMS, β_{13}	.71* (.32)	.20 (.22)	-.01 (.15)
Free Lunch, β_{14}	-.06 (.10)	-.04 (.07)	.04 (.06)
Grade Level, β_{15}	-.15 (.08)	-.11* (.05)	-.04 (.04)
Race (teacher), β_{16}	.37 (.40)	.02 (.30)	-.21 (.22)
Gender (teacher), β_{17}	.07 (.21)	-.17 (.13)	-.25* (.10)
Years teaching (teacher), β_{18}	-.28 (.18)	-.27* (.12)	-.06 (.08)
Time X intervention, β_{19}	.81* (.37)	-.61 (1.38)	1.01 (1.28)
GMS (teacher) X Time X Intervention, β_{20}	.14 (.13)	.17 (.12)	.23* (.11)
TP (student) X Time X Intervention, β_{21}	.09* (.04)	.19** (.03)	.05 (.04)
TP (teacher) X Time X Intervention, β_{22}	-.26 (.19)	-.06 (.16)	-.29 (.15)
Math efficacy (Teacher) X Time X Intervention, β_{23}	.25 (.15)	-.07 (.13)	-.16 (.12)
TE instruction X Time X Intervention, β_{24}	.04 (.07)	-.03 (.06)	-.09 (.06)
TE StuEng X Time X Intervention, β_{25}	.00 (.08)	-.03 (.07)	.09 (.07)
Random effects			
Teacher	.06 (.05)	.02 (.02)	.00 (.01)
Student	2.63** (.11)	.88** (.05)	.86** (.05)
Residual	.77** (.03)	.63** (.03)	.57** (.02)
-2LL	10096.4	8435.8	8326.6

Note: GMS = growth mindset of students.

^a Omnibus χ^2 (2). *p < .05. p **<.01.

Table 30

Covariate Analysis: Teacher Mindset Intervention Predicting Student Achievement with Moderating Teacher Variables

	Achievement
Omnibus ^a	235.85**
Fixed effects	
Intercept, β_0	213.27** (3.52)
Time, β_1	6.46** (.56)
Intervention, β_2	5.34 (4.41)
Race, β_3	-.94 (2.14)
Gender, β_4	-3.25* (1.47)
Free Lunch, β_5	4.07* (1.75)
Grade Level, β_6	-.15.12 (10.11)
Time X intervention, β_7	-9.78 (10.12)
GMS (teacher) X Time Intervention, β_8	1.45 (1.59)
TP (student) X Time X Intervention, β_9	0
TP (teacher) X Time X Intervention, β_{10}	-.19 (.51)
Math efficacy (Teacher) X Time X Intervention, β_{11}	0
TE instruction X Time X Intervention, β_{12}	0
TE StuEng X Time X Intervention, β_{13}	0
Random effects	
Teacher	17.01 (19.18)
Student	92.63** (10.47)
Residual	14.48** (1.66)
-2LL	2419.5

Note:

^a Omnibus χ^2 (2).

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

Table 31

Covariate Analysis: Teacher Mindset Intervention Predicting Teacher Practices (teacher responses) with Moderating Teacher Variables

Omnibus ^b	Teacher practices
	1629.73**
Fixed effects	
Intercept, β_0	4.83** (.60)
Time, β_1	.89** (.05)
Intervention, β_2	.69 (.69)
Race, β_3	.01 (.04)
Gender, β_4	-.01 (.04)
School, β_5	
FHS, β_6	.64 (.93)
IHS, β_7	-.17 (.94)
IMS, β_8	1.48 (1.33)
MCA, β_9	1.03 (.99)
NHS, β_{10}	-.2.72 (1.37)
PHS, β_{11}	.32 (.68)
SCMS, β_{12}	.32 (1.32)
MMMS, β_{13}	.39 (1.01)
Free Lunch, β_{14}	.00 (.04)
Grade Level, β_{15}	.00 (.04)
Race (teacher), β_{16}	-.99 (.98)
Gender (teacher), β_{17}	-.46 (.60)
Years teaching (teacher), β_{18}	.01 (.60)
Time X intervention, β_{19}	2.09 (1.29)
GMS (teacher) X Time X Intervention, β_{20}	-.47** (.12)
Math efficacy (Teacher) X Time X Intervention, β_{21}	-.04 (.15)
TE instruction X Time X Intervention, β_{22}	-.11* (.05)
TE StuEng X Time X Intervention, β_{23}	.14 (.09)
Random effects	
Teacher	1.28** (.52)
Residual	.88** (.02)
-2LL	7569.3

Note:

^a Omnibus χ^2 (2).

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

APPENDIX B: Figures

Figure 1

Conceptual model for teacher based social psychological intervention

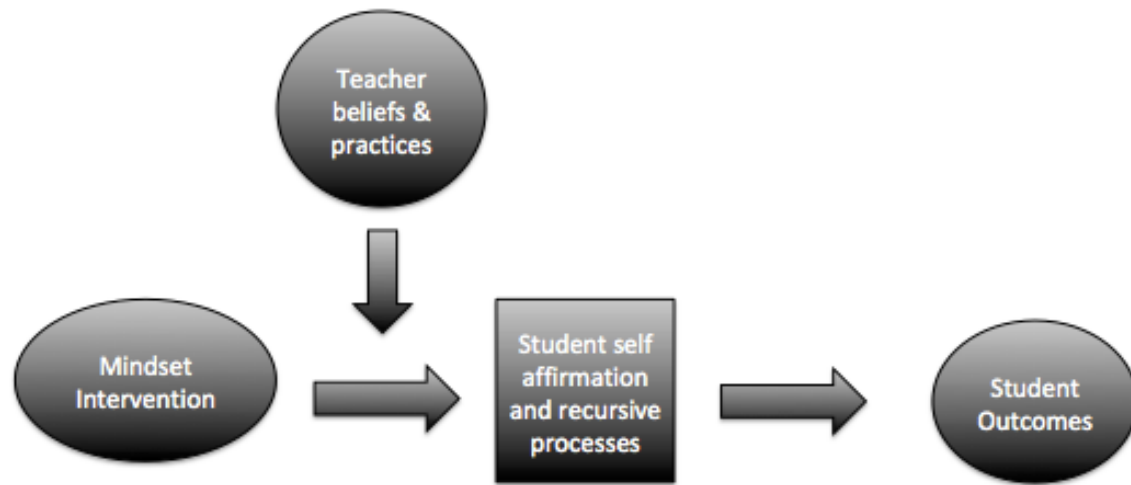
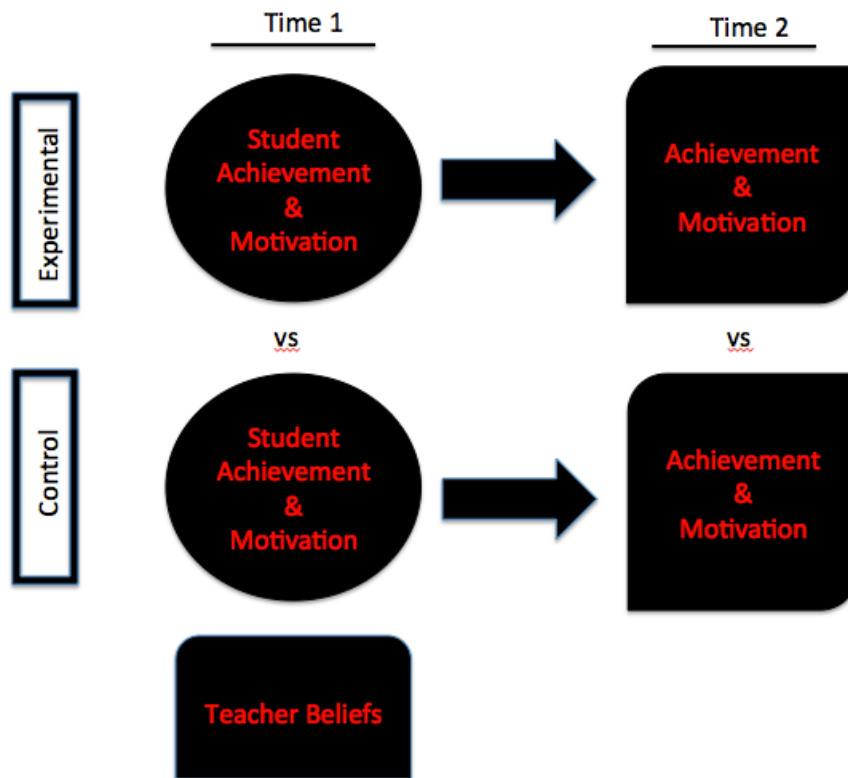


Figure 2

Students' achievement and motivation measures structure



Note: Measured at two time points for both conditions for the students. Teachers' beliefs and motivation were also measured at both time points.

Figure 3

Image of Module 1 activities of the online teacher intervention

← → ↻ blog.mindsetworks.com/moodle/course/view.php?id=5&pageid=8 ☆

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Module 1 – Activities & Projects

Here are some suggested activities and projects for you to try in your classroom:

1. Assess your students' mindsets

Choose one of the following strand activities to explore your own students' mindsets, using the tools provided. You may choose to do the activity individually, with a partner, in collaboration with a small team, or as a whole faculty.

Strand 1 – Whole class focus: Use the [Mindset Assessment Profile](#) activity to assess the mindsets of your students, and discuss the results in the Forum.

You can use this tool in any of the following ways:

- Have your students complete the survey only, collect them, and calculate their scores yourself.
- Have your students self-score and complete and turn in the reflection activity.
- Have the class complete the survey anonymously, share out the aggregate results with the class, and discuss.
- Or any combination of the above!

Strand 2 – Individual student focus: Use tools to do in-depth profiles of 1-2 focus students in order to understand and be better able to support them. For example:

- You can interview the student(s) using questions from the [Mindset Interview Protocol](#). (Feel free to add your own questions, and to share with colleagues!) Note: some students are more comfortable discussing these issues in pairs, some individually, so do whichever you think is best for yours.
- As an alternative, you can ask your students to do a reflective writing assignment based on the questions in the [Mindset Interview Protocol](#).

2. Forum discussions w/colleagues

Then, discuss your results* in the [Results Shareout forum](#). You can upload and share documents there too if you like. Consider the following questions:

- What did you learn about the mindsets of your student(s)?
- What surprised you?
- Do you see a connection between your own students' mindsets and their behavior and performance in school?
- Were there particular areas where they seemed to show more "fixed mindset" motivational patterns? For example, did they lack confidence in their ability to learn certain things? Were they reluctant to take on challenges? Afraid to risk making mistakes? Did they dislike putting in effort? Feel demoralized when things got difficult?
- What would you like to work on with your students?



Figure 4

Image of Module 4 video of the online teacher intervention

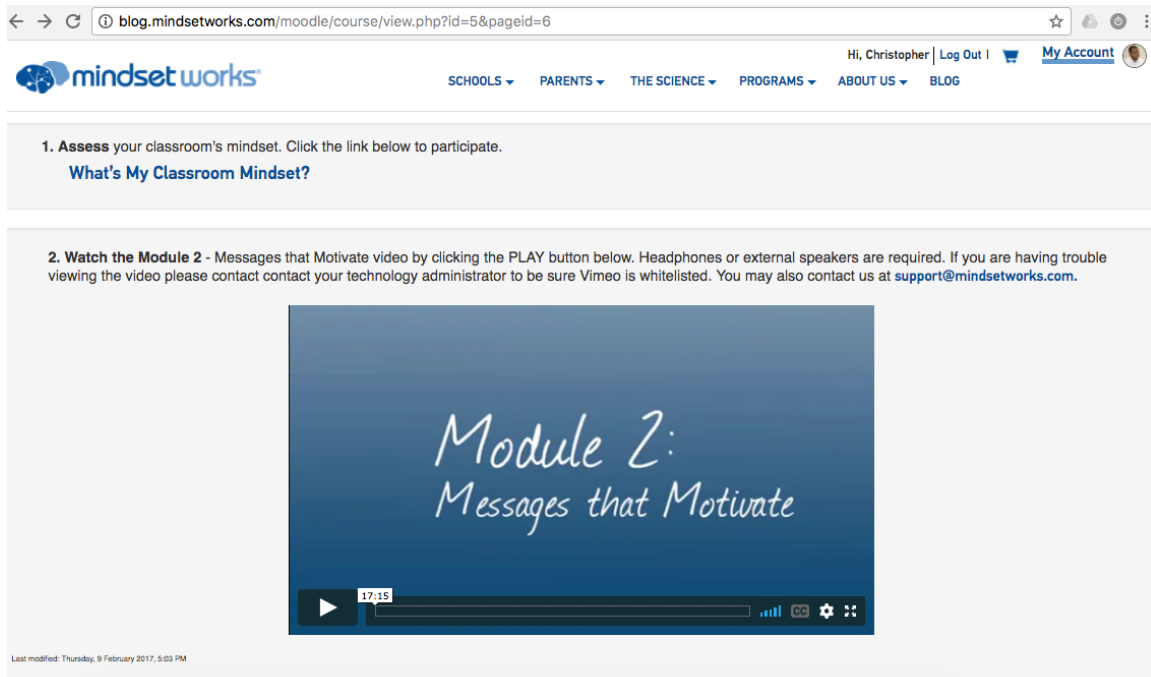


Figure 5

Image of the Module 4 discussion board activity of the online teacher intervention

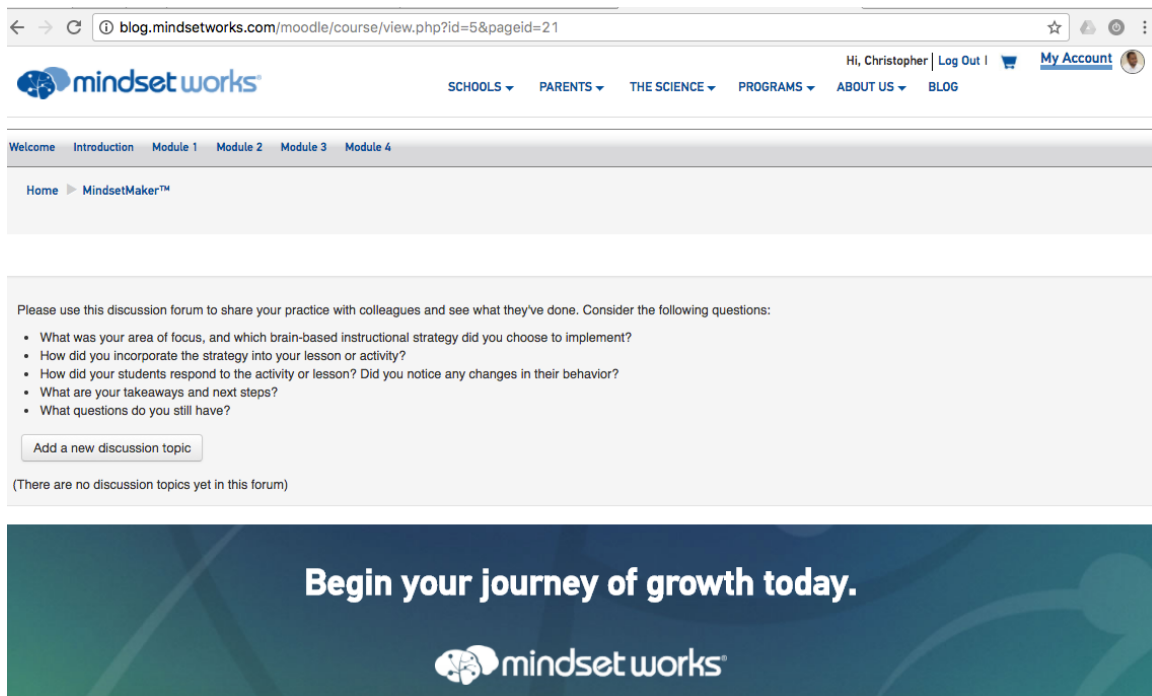


Figure 6

Module descriptions from Mindsetworks Mindsetmaker

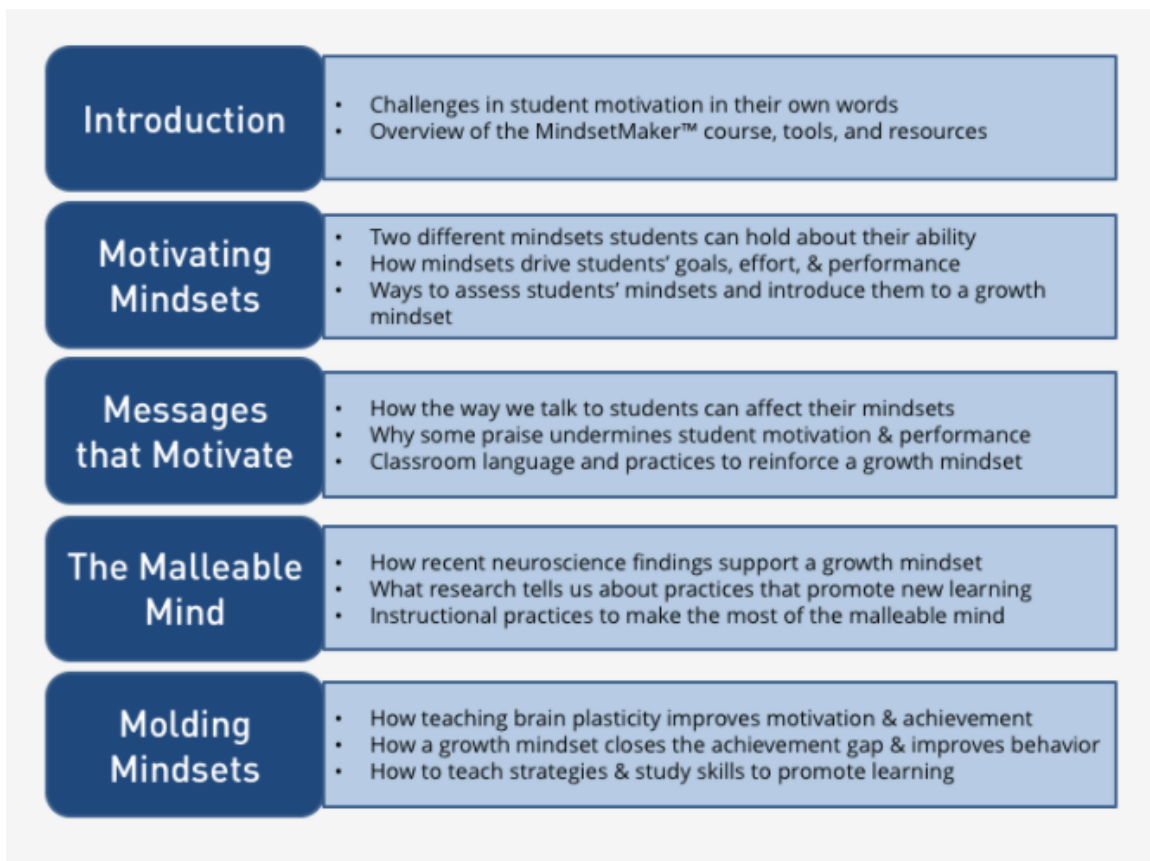
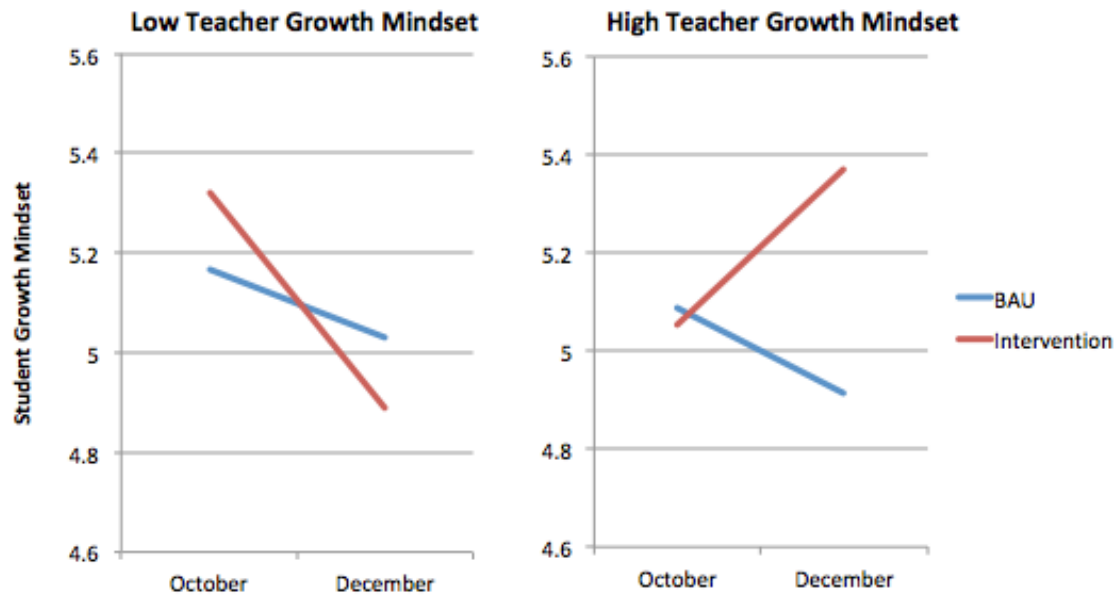


Figure 7

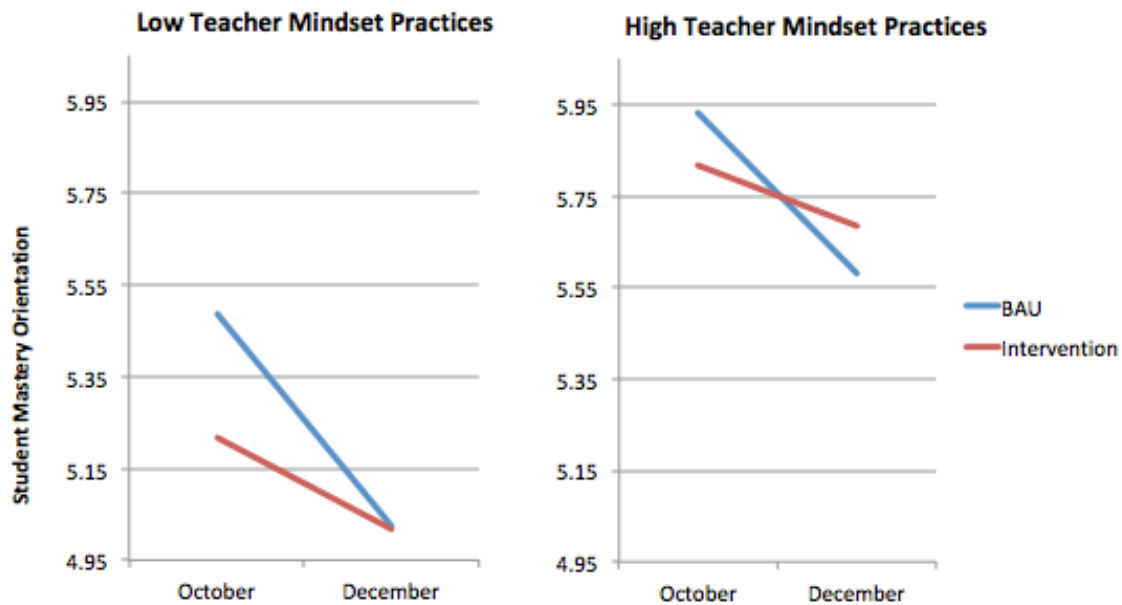
Student growth mindset over time with teacher growth mindset as the moderator



Note: Student growth mindset is on a scale from 1 to 7. Low teacher growth mindset is one standard deviation below the mean and high teacher growth mindset is one standard deviation above the mean.

Figure 8

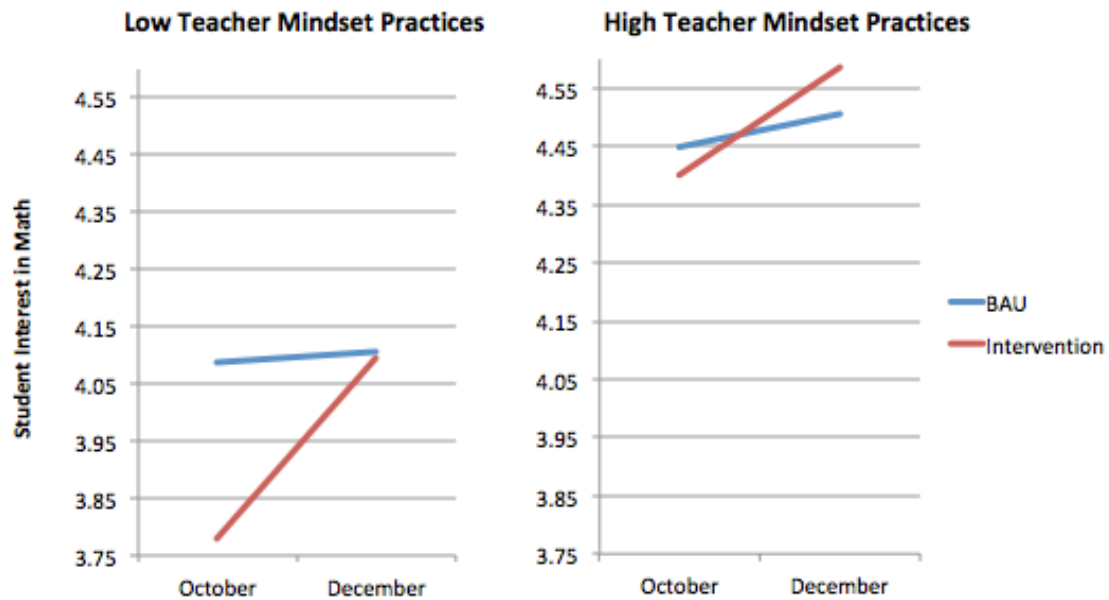
Student mastery orientation over time with student-rated teacher growth mindset practices as the moderator



Note: Student mastery is on a scale from 1 to 7. Low teacher mindset practices are one standard deviation below the mean and high teacher mindset practices are one standard deviation above the mean.

Figure 9

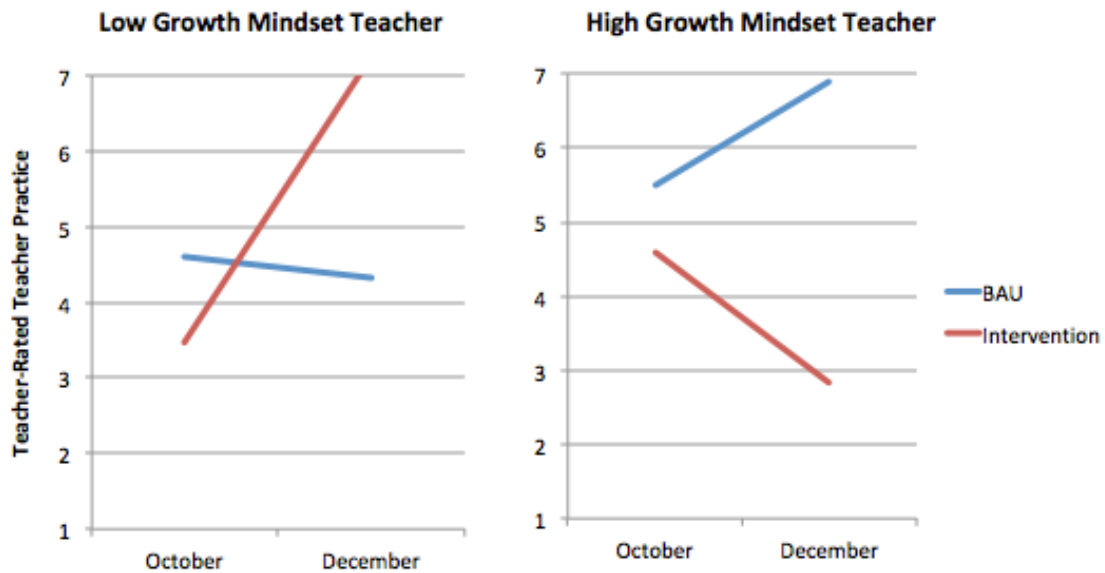
Student interest in math over time with student-rated teacher growth mindset practices as the moderator



Note: Student interest is on a scale from 1 to 7. Low teacher mindset practices are one standard deviation below the mean and high teacher mindset practices are one standard deviation above the mean.

Figure 10

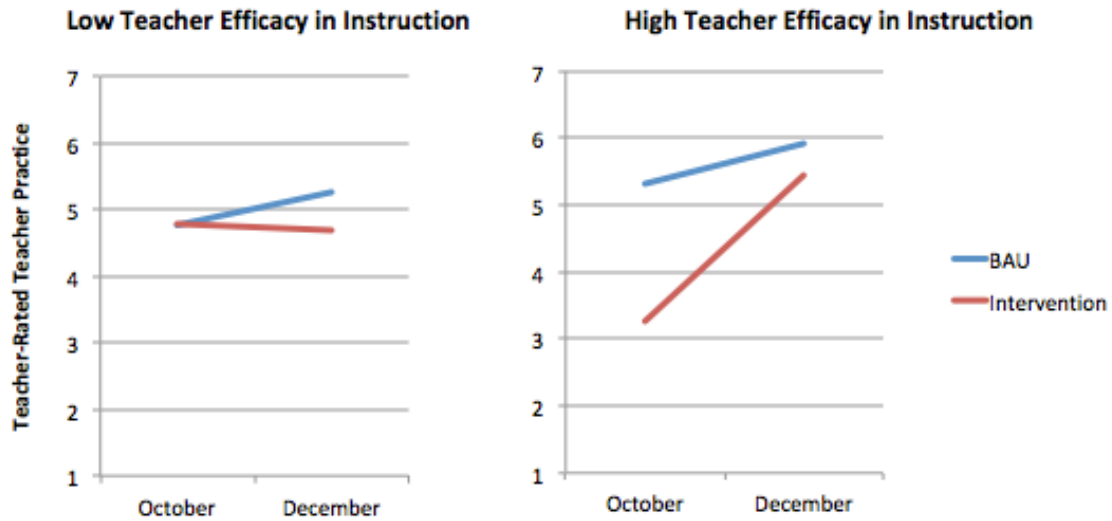
Teacher-rated teacher growth mindset practices over time with teacher growth mindset as the moderator



Note: Teacher practice is on a scale from 1 to 7. Low teacher growth mindset is one standard deviation below the mean and high teacher growth mindset is one standard deviation above the mean.

Figure 11

Teacher-rated teacher growth mindset practices over time with teacher efficacy in instruction as the moderator



Note: Teacher practice is on a scale from 1 to 7. Low teacher efficacy is one standard deviation below the mean and high teacher efficacy is one standard deviation above the mean

APPENDIX C: Measures

View of Ability (Mindset; Dweck, 2007)

You have a certain amount of intelligence, and you really can't do much to change it.*

Your intelligence is something about you that you can't change very much.*

You can learn new things, but you can't really change your basic intelligence.*

No matter who you are, you can change your intelligence a lot.

You can always greatly change how intelligent you are.

No matter how much intelligence you have, you can always change it quite a bit.

Achievement Goal Orientations (PALS, 2000)

Mastery Goal Orientation

It's important to me that I learn a lot of new concepts this year.

One of my goals in class is to learn as much as I can.

One of my goals is to master a lot of new skills this year.

It's important to me that I thoroughly understand my class work.

It's important to me that I improve my skills this year.

Performance Approach Orientation

It's important to me that other students in my class think I am good at my class work.

One of my goals is to show others that I'm good at my class work.

One of my goals is to show others that class work is easy for me.

One of my goals is to look smart in comparison to the other students in my class.

It's important to me that I look smart compared to others in my class.

Performance Avoidance Orientation

It's important to me that I don't look stupid in class

One of my goals is to keep others from thinking I'm not smart in class

It's important to me that my teacher doesn't think that I know less than others in class

One of my goals in class is to avoid looking like I have trouble doing the work.

Perceived Competence in Math (Self Efficacy; PALS, 2000)

I'm certain I can master the skills taught in math

I'm certain I can figure out how to do the most difficult class work in math.

I can do almost all the work in math if I don't give up.

Even if the work is hard in math, I can learn it.

I can do even the hardest work in this math class if I try.

Teacher Efficacy (Tschannen-Moran, & Hoy, 2001)

Efficacy for instructional practices

To what extent can you use a variety of assessment strategies?

To what extent can you provide an alternative explanation or example when students are confused?

To what extent can you craft good questions for your students?

How well can you implement alternative strategies in your classroom?

Efficacy for student engagement

How much can you do to get students to believe they can do well in schoolwork?

How much can you do to help your students value learning?

How much can you do to motivate students who show low interest in schoolwork?

How much can you assist families in helping their children do well in school?

Value Types

Interest (Conley, 2012)

How much do you like doing math?

I like math.

Math is exciting to me.

I am fascinated by math.

I enjoy doing math.

I enjoy the subject of math.

Utility (Conley, 2012)

How useful is learning math for what you want to do after you graduate and go to work?

Math will be useful for me later in life.

Math concepts are valuable because they will help me in the future.

Being good at math will be important when I get a job or go to college.

Attainment (Conley, 2012)

Being someone who is good at math is important to me.

I feel that, to me, being good at solving problems which involve math or reasoning mathematically is (*not at all important to very important*).

Being good at math is an important part of who I am.

It is important for me to be someone who is good at solving problems that involve math.

It is important to me to be a person who reasons mathematically.**

Thinking mathematically is an important part of who I am

Cost (effort, Flake et al. 2015)

This class demands too much of my time.

I have to put too much energy into this class.

This class takes up too much time.

This class is too much work.

This class requires too much effort

Teacher Mastery Goals – Student Perception (PALS, 2000)

My teacher thinks mistakes are okay as long as I am learning.

My teacher wants me to understand my work, not just memorize it.

My teacher really wants me to enjoy learning new things.

My teacher recognizes me for trying hard.

My teacher gives me time to really explore and understand new ideas.

Teacher Practices (indicators of mindset; created for this study)

How often does your math teacher praise you for your intelligence?*

How often does your math teacher praise you for your effort?

How often does your math teacher present challenging tasks as exciting?

How often does your math teacher present easy tasks as boring?*

How often does your teacher promote challenging work over successful work?"

Teacher Work Avoidance (Harackiewicz et al., 2008)

One of my goals is to get through this course by doing the least amount of work possible.

It's important to me to do as little work as possible in my math classes.

One of my goals is to not work hard in math classes.

Behavioral Engagement (Skinner et al. 2008)

I try hard to focus during math class & while doing math homework.

When in math class or doing math work, I work as hard as I can to concentrate.

I take advantage of opportunities to participate during math class.

I pay attention in math class.

When I am in math class, I listen very carefully.

Note: *Item was reverse coded prior to data analyses. **Answered on a different type of Likert scale as opposed to the other items in the same construct.

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