MATH, MINDSET, AND THE
TRANSITION FROM ELEMENTARY TO MIDDLE SCHOOL

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ABSTRACT

A significant transition that most students encounter is the transition from elementary school to secondary school. . This action research project examines the risks and challenges that students encounter during their transition from primary to secondary school, explores some of the psychological factors that tend to mitigate these risks, and suggests a possible intervention to bolster these protective psychological factors using the mindset theory of Carol Dweck. This study asks the following question: when the teacher implements feedback and praise that is directed at students' efforts and strategies, what is the effect on students' dispositions toward challenges and setbacks in middle school mathematics? Two of three students in this research showed significant improvement in their disposition towards mathematics, as measured by academic achievement, participation, risk-taking, and self-confidence. These results suggest adding teacher supports to increase the use of strategy- and effort-based feedback to students.

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CHAPTER 1: LITERATURE REVIEW

Introduction

Significant life transitions can be challenging. For example, going through divorce, changing jobs or schools, or recovering from illness all involve times of transition that add stress to our lives and present challenges to our ability to flourish. A significant transition that most students encounter is the transition from elementary school to secondary school. In the middle school where I currently observe, sixth grade was added for the 2014-2015 school year, meaning that both sixth- and seventh-grade students made this transition during my student teaching. This action research project examines the risks and challenges that students encounter during their transition from primary to secondary school, explores some of the psychological factors that tend to mitigate these risks, and suggests a possible intervention to bolster these protective psychological factors using the mindset theory of Carol Dweck.

Transitional Difficulties

In 1986, the Carnegie Corporation of New York established the Carnegie Council on Adolescent Development, which commissioned a report on the state of education for young adolescents (Carnegie, 1989). This report noted the developmental criticality of adolescence between the ages of 10 and 15 years when "many youth enter a period of trial and error, of vulnerability to emotional hurt and humiliation, of anxiety and uncertainty that are sources of unevenness of emotions and behavior associated with the age" (p. 21). The Carnegie report also asserted that

> most American junior high and middle schools do not meet the developmental needs of young adolescents. These institutions have the potential to make a tremendous

> impact on the development of their students – for better or for worse – yet they have been largely ignored in the recent surge of educational reform. As currently organized, these middle grades constitute an arena of casualties – damaging to both students and teachers. (p. 12)

According to the Association for Middle Level Education (AMLE), "young people undergo more rapid and profound personal changes between the ages 10 and 15 than at any other time in their lives" (AMLE, 2010, p. 5). These changes occur at different rates and times, making young adolescence "a period of tremendous variability among youngsters of the same gender and chronological age in all areas of their development" (p. 5). Developmentally, students are experiencing puberty and increasing awareness of gender identity and gender relationships, and they are experimenting with self-identity. During this transition, students are changing to a new school, with a new peer population and new teachers, and have also transitioned from being the oldest students in the school to being the youngest.

Pitfalls that students sometimes encounter during this transition include higher levels of classroom behavior problems, lower self-esteem, lower academic motivation and achievement, and the beginning of risk-taking behaviors (Bronstein et al., 1996; Veronneau & Dishion, 2010). In a two-year study of math students pre- and post-transition, Eccles, Wigfield, Midgley, Reuman, Mac Iver, and Feldaufer (1993) found that student motivation decreased after the transition to middle school. The decrease in motivation was correlated with increased teacher control (decreased student autonomy), decreased teacher efficacy, lower quality teacher-student relationships, and inter-classroom ability grouping (tracking). Pellegrini and Bartini (2000) observed that social dominance decreased while bullying increased when students transitioned from fifth-grade primary to sixth-grade secondary schools. They hypothesized "that bullying may be one strategy used by youngsters, but especially boys, to establish dominance as they enter their new peer group in middle school" (p. 717). Aggression then declines after a new dominance hierarchy is established. In a study of 280 sixth-grade middle-school students, Grills-Taquechel, Norton, and Ollendick (2010) found significant increases of anxiety during the transition year. They hypothesized that the increase was due to a combination of increased academic expectations, new peer groups, increased, wide-spread bullying, and developmental changes that could be perceived as stressful for youth.

Predictive Factors

Several factors have been shown to predict problems for students transitioning to middle school. Veronneau and Dishion (2010), studying the family-peer environment, found that problem behavior in elementary school was the strongest predictor of problem behavior in middle school. Peer acceptance and rejection and their interaction are also predictors of problematic behavior, and the authors hypothesized that students who experience high levels of peer acceptance may experience increased social status for minor rule-breaking behaviors. The authors note the curious case of students who enjoy high levels of both peer approval and rejection, a combination that was more strongly predictive of problem behavior. On the other hand, having high-achieving friends was predictive of fewer problems, as was a high level of parent monitoring.

Studying family and parenting styles and their role in predicting problem behaviors, Bronstein et al. (1996) explored the effects of parent awareness, support, control, and communication on transitioning students' grades, social behavior, and peer popularity. They found that parental support, defined as the degree to which children felt competent and worthy of love, fostered an increased sense of self-esteem, self-worth, and resilience in times of adversity. Punitive control was found to predict decreased grade achievement and, additionally, decreased sense of self-worth in boys, and increased peer popularity in girls. The authors hypothesized that girls who experience punitive control at home are more driven to seek peer relationships at school.

In a study of four primary schools in the United Kingdom, Bailey and Baines (2012) compared teacher and student assessments of resilience and adjustment before and after the transition to middle school. Three post-transition outcomes were predicted by initial measures. Teacher-rated overall student adjustment correlated with pre-transition levels of behavior problems, level of mathematics attainment, and student-rated self-efficacy. Academic progress was positively predicted by student-rated access to support structures, and negatively predicted by sensitivity to adversity and impairment, defined as the degree to which emotional upsets impact other areas of the child's functioning. Levels of peer relationships were negatively predicted by student-rated self-efficacy and impairment.

Grade configuration is another predictor of student transitional difficulty, but the research is mixed. Cook, MacCoun, Muschkin, and Vigdor (2008) found that North Carolina students who attended sixth grade in middle school had increased citations for discipline problems, and decreased end-of-grade test scores when compared to students attending sixth grade in an elementary school. On the other hand, Weiss and Kipnes (2006) did not find significant differences in behavior or grades between Philadelphia students who attended K-8 or middle school.

The National Educational Longitudinal Study (NELS) surveyed 24,599 students across the country in 1988, and then resurveyed a subset of the students again in 1990, 1992, 1994, and 2000. This data allowed researchers to more closely study the challenges that students faced during educational transitions. Studies that relied on NELS data have huge sample sizes with diverse representation of students, and because NELS was longitudinal, effects in one cohort could be tracked across many grades. Eccles, Lord, and Midgley (1991), using data from the NELS, found no differences in behavior or achievement between different middle level grades configurations (6-8, 7-8, 7-9), but did find differences when comparing middle school students with K-8 students, suggesting that whether or not sixth grade is incorporated into middle school is a factor. One limitation to the transferability of this study is that it did not consider differences between K-8 and K-6 school configurations, meaning that some of the results could be due to the developmental stage of the students rather than the transition from elementary school to middle school.

In summary, the research demonstrates that the transition from elementary school to middle school can raise a number of difficulties for students. Students are undergoing major developmental changes at the same time that their school environment is significantly changing. During their transitional year, students can face threats to their self-esteem and motivation. I next consider factors that may protect students from these threats.

Protective Factors

Research shows that certain factors seem to protect students from transitional difficulties. In their report on factors for success in the 21st century (U.S. Department of Education, 2013), the Department of Education identified several psychological factors that it considers critical for students to be successful. Two factors identified in the report are academic tenacity and resilience. Academic tenacity consists of several other relevant properties, including self-regulation and self-esteem. One of the challenges with terms like *resilience* or *self-esteem* is that they represent psychological constructs that are complex and interact with each other in complicated and dynamic ways. One goal of this research is to learn how these constructs act to help students successfully navigate the transition to secondary school.

Self-Esteem

Mruk (2006) defined *self-esteem* as a two-dimensional construct consisting of self-competence and self-worth. Self-competence is the sense that one can act successfully in the world. However, it should be understood that general competence does not seem related to self-esteem; rather, self-esteem has to do with being able to successfully perform actions that matter to us. A student who plays piano, for example, is unlikely to feel low self-esteem because of a lack of ability to play the violin. Self-worth is simply the degree to which one values oneself. Taken to an extreme, self-worth could begin to look like narcissism (a reason Mruk thinks that self-esteem construed as self-worth alone is too restrictive).

By defining self-esteem in terms of two independent components, Mruk (2006) allowed for people to be in one of four states of self-esteem: high and low self-esteem, in which both components are, respectively, high and low, and *defensive self-esteem* in which one component is high and the other low. Working with Mruk's definition, Jindal-Snape and Miller (2008) asserted that a student might have high self-worth but low self-competence:

> In a classroom, such children may feel secure in terms of being accepted and receiving positive messages about themselves as individuals, but have learned that they are often not able to perform age-appropriate tasks effectively. A consequence

> of this is that when the demonstration of some kind of competence is called for, such individuals may feel threatened and employ various avoidance and/or denial strategies. (p. 224)

On the other hand, a student might have low self-worth but high self-competence:

> According to Mruk, their behaviour patterns are likely to include a range of anti-social behaviours, … extreme forms of this type of defensive self-esteem behaviour have been linked to a range of deviant behaviours. (Jindal-Snape & Miller, 2008, p. 225)

Self-esteem is relevant to the transition to secondary school because this is "a period where an individual's sense of worth and competence are particularly vulnerable" (Jindal-Snape & Miller, 2008, p. 226). The authors conclude that students with low self-esteem are less motivated and less persistent in the face of failure.

Self-Regulation

Self-regulation is alternately called *self-control* and *self-discipline* and refers to the ability to consciously delay gratification in service of some higher goal (Duckworth & Seligman, 2006). Examples for students would include choosing to study for a test instead of watching television, or choosing to keep one's cool in a heated situation instead of reacting with an outburst. Rudolph, Lambert, Clark, and Kurlakowsky (2001) noted the joint contribution to self-regulation of one's expectations of outcomes along with one's personal investment in outcomes. Self-regulation is linked to both self-competence and self-worth. Rudolph et al. (2001) found that students with maladaptive self-regulation skills (either low sense of expectation or low sense of investment) were more likely to experience depression when transitioning to middle school as sixth graders, as compared to sixth graders who remained in elementary school. Self-regulation is also a predictor of certain kinds of school achievement.

Girls tend to earn higher grades than boys in elementary through high school, in contrast to their lower relative scores on some achievement tests, including the SAT, ACT, and standard IQ tests (Duckworth & Seligman, 2006). Curiously, these tests underpredict the grade achievement of girls, and overpredict the grade achievement of boys. Several explanations have been proposed and studied for the fact that boys outperform girls on achievement tests, but these studies fail to explain girls' superior grades. Consequently, there must be one or more gender-specific correlates to high grade-point average that do not correlate with achievement test performance. Duckworth and Seligman (2006) demonstrated that girls score better on tests of self-regulation and have proposed that self-regulation correlates with higher grade-point average.

In two studies, Duckworth and her colleagues proposed that the ability to stay on task without direct supervision is an essential ability for middle school students' success (Duckworth, Gollwitzer, Oettingen, & Mayer, 2011; Duckworth, Kirby, Gollwitzer, & Oettingen, 2013). Students who have a higher ability to self-regulate in the service of long-term goals are likely to have better achievement in middle school. The authors have suggested *mental contrasting* as a means of improving self-regulation in service of wish fulfillment (Duckworth et al., 2011). Mental contrasting is a process of focusing attention both on a wish for some future achievement and also on the most significant obstacle to fulfilling that wish. For example, a student wishing for a good grade on a math test would imagine not only getting the good grade, but also imagine the biggest obstacle to getting that grade – perhaps not getting extra help. Compared to students who only focus on academic wish fulfillment, students who also engage in mental contrasting were shown to have increased grade-point average, attendance, and classroom behavior (Duckworth et al., 2013).

Resilience

Luthar, Cicchetti, and Becker (2000) defined *resilience* as “a dynamic process encompassing positive adaptation within the context of significant adversity” (p. 543). Masten and Coatsworth (1998) included the notion of competence, defining resilience as manifesting competence in the context of significant challenge. By defining resilience in terms of competence, Masten and Coatsworth (1998) expressed a dynamic relationship between resilience and self-esteem. Further, competence is increased through the self-regulation of attention, emotions, and behavior. “Later in development, good attention regulation has been linked to prosocial behavior and peer popularity, whereas difficulties in regulating attention have been linked to attention-deficit/hyperactivity disorder (ADHD), antisocial behavior, and academic problems” (Masten & Coatsworth, 1998, p. 208).

An aspect of resilience that is important for this work is that it does not seem to be limited to extraordinary individuals. Masten (2001) explains that “resilience appears to be a common phenomenon that results in most cases from the operation of basic human adaptational systems” (p. 227). These basic adaptational systems consist, at least in part, of self-regulation and self-esteem, and it is when these components are impaired that individuals manifest negative adaptation to adversity. Even as successful adaptation (resilience) acts to improve one’s sense of self-esteem and self-regulation, so does having high self-esteem and self-regulation act to bolster one’s resilience.

Resilience, self-regulation, and self-esteem operate in a complex, interrelated, and dynamic fashion to help students successfully navigate the transition from primary to secondary school. Masten (2001) suggested that when these components operate in an impaired manner, students can display negative adaptations to the challenges of transition. Is it possible for an intervention to help students during this transitional time by bolstering these three psychological components?

Mindset

Mindset theory, proposed by Carol Dweck (2000), describes two different ways of perceiving one's abilities. People with a *fixed mindset* (also called *entity theorists*) believe that abilities such as intelligence are of a fixed amount. Entity theorists perceive failure as a measure of their fixed amount of intelligence, and this has ramifications for their sense of self-competence. "Thus, people holding an entity theory (entity theorists) may explain negative performance more in terms of their lack of ability than effort, which would render them vulnerable to helpless responses in the face of failure" (Hong, Chui, Dweck, Lin, & Wan, 1999, p. 589). In contrast, people with a *growth mindset* (also called *incremental theorists*) believe that abilities like intelligence are malleable and can be improved with effort. Because of their belief that intelligence can be improved, incremental theorists are more likely to respond to failure with effort. Hong et al. (1999) found that, relative to entity theorists, incremental theorists

- focused more on learning goals and less on performance goals;
- believed in the utility of effort;
- displayed *mastery-oriented* strategies (increased effort, changed strategy) more than *helpless-oriented* strategies (effort withdrawal, strategy perseveration) in response to failure.

Students with an incremental mindset who are transitioning to middle school enjoy an advantage over entity theorists in overall grades achieved (Blackwell, Trzesniewski, & Dweck, 2007). Importantly, the authors showed that these incremental theorists also enjoyed higher grades during their entire time in middle school. These advantages seem to be conferred by students believing in the value of effort and embracing learning goals, both of which increased the use of positive strategies and decreased a helpless response to failure.

How does mindset theory relate to self-esteem, self-regulation, and resilience? An issue for students is how they repair self-esteem after receiving negative feedback. Several defensive strategies have been studied by Nussbaum and Dweck (2008), including dismissing negative feedback as inaccurate or biased and comparing oneself with worse-off others. These strategies repair self-esteem without addressing the underlying cause of the negative feedback. Nussbam and Dweck (2008) investigated how college students would react to negative academic feedback when given an opportunity to remediate the feedback, and, importantly, whether the students' self-perception of intelligence (fixed or malleable) influenced that reaction. The authors hypothesized that entity theorists would react differently than incremental theorists when their self-esteem was threatened. Importantly, in this study, the participants were randomly induced to hold an entity or incremental perspective, demonstrating that mindset is alterable. Nussbaum and Dweck (2008) showed that entity theorists repaired self-esteem by comparing their performance to lower performing individuals, while incremental theorists tended to compare themselves with higher performing individuals. That is, students who were induced toward an incremental mindset were more likely to repair loss of self-esteem by attempting to remedy the cause of the negative feedback instead of reacting to it defensively.

Job, Dweck, and Walton (2010) considered the effect of incremental and entity theories on self-regulation. The authors note "much recent research suggests that willpower—the capacity to exert self-control—is a limited resource that is depleted after exertion." (p. 2). However, Job et al. (2010) showed that people who hold an incremental view of willpower did not experience a depletion of their ability to self-regulate on subsequent tasks. Finally, Molden and Dweck (2006) noted the relevance of mindset theory to young adolescence. "Many beliefs about ability are developing over the grade school years, but they do not relate well to each other and they do not reliably predict motivation and behavior until about 10 –12 years of age" (Molden & Dweck, 2006, p. 201). This is the age at which many students are transitioning to middle school.

Romero, Master, Paunesky, Dweck, and Gross (2014) examined the effects of incremental and entity theory on students' choices of classes and emotional well-being. Though the study had a small sample size and suffered from a relative lack of racial diversity, both of which limit its generalizability, it did show significant differences in outcomes. Students who held an incremental theory of math intelligence were more likely to choose challenging classes, and students who held an incremental theory of emotional control scored higher on self-assessments of emotional well-being.

In order for an intervention based on mindset theory to be possible, we would need to be able to change a student's entity theory into an incremental theory. Hong et al. (1999) suggest that both theories are present in individuals and that the individual's preferred theory can be manipulated.

> The rationale behind this manipulation was that although people might have chronic preferences for one theory or the other, both theories may represent basic modes of

> thought that are at some level familiar to most individuals… Thus after reading persuasive arguments professing an entity or incremental theory, participants may be led to adopt that particular mode of thought. (Hong et al., 1999, p. 594)

Additionally, Dweck (2000) showed that the way praise and criticism are used can affect the mindset that a person adopts. Dweck found that praise and criticism directed at the person or at an attribute (such as intelligence) tended to shift a person toward an entity theory, while praise and criticism directed at a person's effort and strategies shifted the person toward an incremental theory. Praise for a student's effort should foster an incremental theory for that student.

Mindset In A Math Classroom

Mathematics is frequently perceived by students to be a more challenging subject in middle school, compared to elementary school (Blackwell, et al., 2007; Hoyles, 1982; Midgley, Feldlaufer, & Eccles, 1989; Stodolsky, Salk, & Glaessner, 1991). Many students experience increased anxiety, decreased optimism, and decreased grades in middle school mathematics (Midgley et al., 1989). Stodolsky, Salk, & Glaessner (1991) reiterate these experiences asserting that "when discussing math, pupils expressed strong feelings about learning and their own competence, in contrast to stories about other school subjects. In particular, bad math experiences were characterized by feelings of anxiety, shame, and inadequacy" (p. 92).

In a pair of studies, Blackwell, Trzesniewsky, and Dweck (2007) explored the relationship between mindset and middle school students' performance at mathematics. Building on an existing body of research that showed the positive effects on academic achievement of holding an incremental theory of intelligence, the authors sought to show whether such an incremental theory might lead to a long-term academic advantage for students. Further, the authors tried to explain why holding an incremental theory led to increased achievement, and also whether specifically teaching an incremental theory to students would yield any added benefit over other academic interventions. Both studies involved middle school students in small, racially and socioeconomically diverse, public middle schools in New York City. In both studies, 6^{th} grade math scores were used as a baseline for academic achievement in middle school and a single survey was used to group students into incremental or entity theory. The first study used data gathered from a five year longitudinal study of four cohorts (393 students) as they transitioned into middle school (seventh grade) for two years until they moved on to ninth grade in high school. The second study involved 99 seventh grade students for a single school year during which a growth mindset intervention was given to randomly selected classes. This mindset intervention consisted of teaching students that when they learn, their brains grow new pathways and they become more intelligent, and, importantly, that the students themselves are in charge of growing their brains.

Blackwell et. al (2007) found that students who held an incremental theory of intelligence had higher mathematical achievement in middle school than students who held an entity theory. In the first study, students with an incremental theory saw their math grades increase each year during middle school, while their entity theory peers saw their grades decrease slightly over time. Interestingly, student theory of intelligence did not correlate with achievement in sixth grade math scores, but seems to have made a significant difference when students transitioned to middle school. The authors found that incremental theory students had four motivational attributes that differed from their entity theory peers.

Incremental theorists had stronger belief in the efficacy of effort, were more likely to value learning, were more likely to view setbacks as an opportunity to learn (instead of as a measure one's talent), and, as a result, were more likely to choose positive strategies for learning. The authors suggest that these four characteristics represent the pathways by which incremental theorists have higher achievement than their entity theorist peers. The second study extended these results by showing that students who are taught an incremental theory of intelligence exhibited academic gains similar to the incremental theory students in the first study. Further, the change was most pronounced with students who began with an entity theory of intelligence, and were taught an incremental theory.

Blackwell, et. al (2007) note several limitations in the studies. First, both were conducted at a single, small, public school, and though both studies produced consistent findings, it is possible that factors specific to a single school influenced the results. Second, the second study only followed students for a short time. Though the study lasted for a school year, the intervention occurred during the spring quarter so findings are relevant for a much shorter amount of time than in study 1. Third, the authors found it difficult to identify the exact underlying reason for the increased achievement of the incremental theory groups. This was because of the complex interrelationship between the four characteristics identified in the incremental theorists (see above). It remained unclear which relationships were critical to the increased achievement; for example, perhaps response to failure leading to improved strategies was more important than having a strong belief in effort. The studies suggest, nevertheless, the benefits of holding an incremental theory about intelligence. Both studies show strong internal validity, with low experimental mortality in study 2 (n=4), and with history and maturation factors affecting both control and experimental groups equally. In the intervention study, the authors were careful to create a simultaneous, similar intervention for the control group that omitted mention of incremental or entity theories of intelligence in order to minimize compensatory and novelty effects. Additionally, steps were taken to minimize differences in gender and race between intervention leaders for each of the control and experimental groups. Finally, in both studies, control and experimental groups participated in pre- and post-test surveys minimizing threats to generalizability.

Good, Rattan, and Dweck (2012) found that females in math classes suffered from a sense of not belonging because math was perceived to require high ability. The authors hypothesized that feeling a sense of belonging was a critical factor for persistence in a field of study, and so, sought to determine what affects one's sense of belonging. In a series of three studies, the authors first created and validated an internally consistent survey for measuring students' sense of belonging in a math class. Next, they used this survey to identify the extent to which students' sense of belonging correlated to their disposition towards mathematics. This study, involving 133 college students at a northeastern university, used pre- and post-test surveys to explore students' dispositions toward math such as math anxiety, perceived usefulness of math, confidence in math, and intent to pursue future mathematical studies. Finally, in a study of over 1000 calculus students at an east coast university, the authors sought to determine the relationship between incremental/entity theory of intelligence and sense of belonging in a math class over the course of an entire school year. This study considered both students' own self-theory about intelligence, and their perceptions about the class environment, i.e. whether the mathematical environment conveyed a sense of intelligence as fixed or malleable. By administering surveys at the beginning, midpoint, and end of the school year, this last study measured the effect of perceptions about personal and environmental theories of intelligence over time.

Good, Rattan, and Dweck (2012) found that sense of belonging was a strong predictor of students' intention to pursue math in the future. Additionally, females who scored high on the sense of belonging survey also reported lower math anxiety, and increased confidence and a sense that math was a useful pursuit. In the study of calculus students, the authors explored the link between incremental/entity theory and sense of belonging, finding that female students who subscribed to an incremental theory of intelligence had a higher sense of belonging than female students. Beyond the students' own self-theories of intelligence, when they perceived the classroom environment to be supportive of an incremental theory of intelligence, they were more likely to feel a sense of belonging, and the more they perceived the classroom to be supportive of an entity theory, the less likely they were to feel a sense of belonging. Importantly for teachers, students' sense of belonging at the beginning of the year was not a predictor of intent to pursue further mathematical studies; however, the reduction of sense of belonging for females was a strong predictor for intent to pursue future studies.

Study 1 had the purpose of establishing a survey to measure the degree to which students feel a sense of belonging. This study combined a large (n=997), heterogeneous sample and established the survey as highly internally consistent (Cronbach alpha ranged from .78 to .95). This survey was then used as a primary measure in the two follow-up studies and lends a high internal validity to both. Studies 2 and 3 both suffered from moderate experimental mortality. To address this, the authors used a technique for estimation on the basis of missing data being randomly distributed. They note that similar results were obtained between the estimated, complete population and the smaller number of students who completed each entire study.

The authors note three limitations of the final study. First, the study was not experimental so the authors are cautious about a causal relationship between perceptions of learning environment and student aspirations. The authors note, however, that initial feelings of belonging were controlled for, and that pre- and post-surveys of perceptions predicted sense of belonging, both of which lend support to a causal relationship. Second, the students' sense of belonging was not manipulated, so it is possible that the causal relationship works in reverse, i.e. perhaps it was students' aspirations to pursue mathematics that influenced their sense of belonging. The authors did include variations to their models to test for this possibility and were unable to find support for this outcome. Third, while the study highlights the importance of students' perceptions of the classroom theory of intelligence, it does not consider how those perceptions are communicated by the teacher or by other students. The authors note one possibility is that the teacher's own self-theory of intelligence influences how that teacher communicates with students, which in turn, influences students' own self-theories of intelligence.

Rattan, Good, and Dweck (2012), in a series of four studies, explored the relationship between teachers' self-theory of intelligence, teacher's choice of language when giving feedback to students, and the effect on students' motivation and expectations for success. Study 1 involved 41 undergraduate students at a private, west coast university. Participants were given a self-theory of intelligence assessment as well as a survey about their sense of belonging (Good, Rattan, & Dweck, 2012), and then asked to imagine teaching a seventh-grade math class in which a particular student received a 65% on a test. Finally, participants were asked to what degree they thought this student performed poorly because of a lack of mathematical ability. Studies 2 and 3 were identical in nature, with study 2 involving 95 undergraduate students at a public, east coast suniversity, and study 3 involving 41 graduate students at a private west coast university, who were actual classroom teachers. In each study, participants completed a self-theory of intelligence assessment and were then asked to imagine a scenario similar to that in study 1. Then the participants were asked whether the failing student in the scenario was likely to improve on future tests, and the degree to which they would use comforting feedback, e.g. "not everyone is good at math", and the degree to which they would recommend strategies likely to disempower the student, e.g. dropping the class. Finally, in study 4, 54 undergraduate students at a private, west coast university were given a scenario to read in which they had failed a math test and then received either comfort-oriented feedback, which focused on strengths besides math, strategy-oriented feedback, which focused on concrete suggestions, or control feedback, which was comforting without mentioning math ability. Students then completed a survey to determine how they viewed their professor's expectations of them, their level of motivation to try harder, and their expectation for improvement.

Rattan, Good, and Dweck (2012) found that teachers who hold an entity theory about intelligence were more likely use feedback attempting to comfort students who were struggling with math because they believed the students lacked math ability. In study 1, participants who held an entity theory of intelligence were more likely to attribute students with a lack of math ability based on a single failure, while those holding an incremental theory were more likely to attribute student failure to a lack of effort. In studies 2 and 3, participants who held an entity theory of intelligence, compared to those holding an incremental theory, were significantly more likely to respond to student failure with comforting feedback and with strategies that were likely to disempower students. Finally, in study 4, compared to the strategy and control groups, participants who received the comforting feedback believed their professor to have lower expectations for them, were significantly less motivated to improve, and expected to receive low grades in future tests. Additionally, compared to the control group, participants who received strategy-based feedback had a higher sense of expectation from their professor and a stronger motivation to improve.

Study 1 had the purpose of establishing a survey to measure the degree to which students feel a sense of belonging. This study combined a large (n=997), heterogeneous sample and established the survey as highly internally consistent (Cronbach alpha ranged from .78 to .95). This survey was then used as a primary measure in the two follow-up studies and lends a high internal validity to both. Studies 2 and 3 both suffered from moderate experimental mortality. To address this, the authors used a technique for estimation on the basis of missing data being randomly distributed. They note that similar results were obtained between the estimated, complete population and the smaller number of students who completed each entire study.

To summarize, students' success in a middle school math class is linked to their motivation to engage with challenges, their belief in effort rather than innate math ability, and their response to setbacks with mastery-oriented strategies. Research in this literature review has shown that students have very different dispositions toward engaging challenging mathematics, and toward responding to the inevitable setbacks they encounter. Further, the research has shown that teacher feedback and praise can affect student dispositions toward challenges and setbacks by affecting whether students adopt an entity or incremental theory of math ability. Specifically, feedback directed at the student's effort or strategy effects a shift toward an incremental theory of math ability (Dweck, 2000; Rattan, Good, & Dweck, 2012). Finally, it is expected that if students adopt an incremental theory, they will see improvement in their self-esteem and self-regulation, both of which affect students' resilience, leading to what Dweck (2013) calls academic tenacity.

Action Research

Teacher feedback and praise can affect students' theories about their math ability, thereby affecting their dispositions toward engaging challenges and learning from setbacks. It is therefore critical that I increase my use of feedback and praise directed toward students' efforts and strategies. This action research project asks the following question: when the teacher implements feedback and praise that is directed at students' efforts and strategies, what is the effect on students' dispositions toward challenges and setbacks in middle school mathematics? To answer this question, it will be required to understand the dispositions that students hold toward mathematics at the beginning of the year and whether there is any difference in their dispositions after receiving feedback. It will also be required to monitor the degree to which I, as teacher, direct feedback and praise at student effort and strategies, and not at the students themselves or their abilities.

CHAPTER 2: METHODS

Setting and Participants

Aladdin Middle School[1] is a public middle school, located in a small, urban community in the Pacific Northwest. During the 2013-2014 year, the school served 568 students in the seventh and eighth grades. The students are about 54% male, 3.5% transitional bilingual, and 48% reduced lunch. The student racial makeup is 46% European American, 22.7% Hispanic, 5.3% African American, 10.4% Asian / Pacific Islander, 2.1% American Indian / Alaska Native, while the remaining 13.6% are two or more races. The school consists of a main building with two portable modular units, one of which houses all math classes. The school grounds contain a covered, outdoor basketball court, a track, soccer field, and several baseball/softball diamonds. The school is located in a mostly residential area, but is also just minutes from the nearest business district.

During the 2012-2013 school year, Aladdin Middle School ranked somewhat below district-wide percentages of students with passing standardized test scores in mathematics. District-wide scores are, in turn, very similar to statewide student scores. Aladdin had an improvement plan for student scores in the 2013-2014 school year, and is reviewing new targets as assessment is changing from the current statewide standardized testing to the new CCSS-aligned Smarter Balanced tests. Table 1 compares Aladdin's math scores with district and state scores.

[1] All of the names in this paper are pseudonyms to protect the identity of the school and participants.

Table 1

Aladdin Middle School, District, and State Math Scores

2013-2014 Year	% Passed, Grade 7	% Passed, Grade 8
Aladdin	50	55
District-wide	64	54
State-wide	64	53
Aladdin 2014-2015 Target	*69*	*68*

My students are a class of sixth-grade students in a tracked intervention program called Key Elements to Mathematical Success (KEMS). Students are placed in KEMS when they fail to score highly enough on standardized tests from the prior year, or based on teacher recommendation. During the 2014-2015 school year, Aladdin Middle School added a new sixth-grade cohort to its campus, meaning that there will be two years of students who are transitioning from elementary to middle school. This grade configuration is now standard for all middle schools in the district. For the purposes of this study, I will be focusing on the sixth-grade students as they are beginning their transition from elementary to middle school.

From a pool of seven students who volunteered to be interviewed, three female students were chosen for interviewing during weeks 8 and 15 of the quarter. Luci showed a strong, positive disposition towards mathematics, claiming it was her favorite subject, and her mindset survey measured almost exactly between fixed and growth. This student was a frequent participant in class discussion and often asked for more challenging work when she had finished an assignment. Emily showed a negative disposition towards mathematics and an extreme fixed-mindset. Early in the quarter, student E rarely participated in class discussions and rarely finished in-class assignments. Maggie showed a somewhat negative disposition towards math, and a slight growth mindset. Maggie was extremely shy at the beginning of the year, never participating in class discussions and never working on more advanced problems, but showed relatively strong math skills during assignments. These three students were selected for interviews because they represented a range of dispositions and mindsets.

The classroom is behind the main building in one of the portable units along with five other math classrooms and two restrooms. There are 28 desks arranged into groups of four. The large number of desks, along with the position of the teacher's desk, can make it difficult for the front corner groups to see the projector display. The projector is ceiling mounted and projects onto a large white board in the front of the room. The projector can be sourced by either a desktop computer or a document camera. The room also has audio capability so it is possible to show video clips, for example. The document camera is positioned at the rear of the room, next to the teacher's desk, making it straightforward to switch projection between the document camera and desktop computer. However, this location requires that the teacher also be in the back of the room, away from the white board, if the display needs to be updated. This creates challenges for providing feedback, and for this reason, I don't use the projector system when leading whole class discussions.

Math Curriculum

The entire school district adopted Common Core State Standards in the 2014-2015 year, along with the associated Smarter Balanced assessments. This prompted a change in district math curricula from Connected Mathematics to EngageNY, a K-12 curriculum maintained by the New York State Education Department. The EngageNY materials are free for use by other school districts, and are available as editable documents. Teachers at Aladdin Middle School were allowed to use EngageNY content during the 2013-2014 school year as they saw fit, and I had the opportunity to use them for several lessons that I taught during my practicum placement there.

The math support program at Aladdin uses a dedicated KEMS curriculum published by the National Training Network. Our materials consisted of student and teacher copies of the KEMS workbook and various manipulatives, for example paper fraction strips. While the students followed a heavily prescribed and paced common core curriculum in their core math class, the KEMS program allowed for more flexibility in working with students. In place of a pacing guide and standardized tests, the KEMS program used "progress monitoring", a computer based assessment that occurred roughly once each quarter. The progress monitoring tests served to approximately guide the instruction, but there were no penalties associated with poor performance, so the KEMS teachers were allowed significant flexibility to spend time when appropriate. For example my KEMS class altered the proposed order for studying fractions and spent over a week longer than originally expected. This was to better align our studies with the students' core math class, and because more time was needed to bring every student to proficiency.

For the 2014-2015 school year, the school district made a conscious effort to promote growth mindset for the KEMS program. Teachers were introduced to the idea during an optional summer workshop and encouraged to read Carol Dweck's *Mindset* (Dweck, 2008). Teachers were also made aware of online video resources about mathematics, created for students by Jo Boaler. These videos were largely concerned with the idea that anyone can do math and not just smart people, and also that students can grow their brains by doing math. The specific language about growth and fixed mindsets was talked about briefly. Each of the videos was between one and three minutes in length, and I showed the first five of these videos during the first two weeks of class. Two students, including Emily who was part of the student interview process, transferred into our class after the second week and so did not have a chance to see the math videos.

Data Collection

The purpose of this action research was to explore the effect of specific kinds of feedback on students' dispositions toward challenges and setbacks in mathematics. I wanted to understand what the effect was when I used feedback that was oriented to students' strategies and efforts rather than oriented to the students themselves. I further wanted to understand this effect both for an entire class, and for individual students. To accomplish this, I collected data about both my own use of language, and about students' dispositions toward mathematics.

In order to make sense of my language use, I decided to limit my considerations to three recurring activities that specifically involve feedback opportunities. These three activities are number talks, opening problems, and pair work, and are described next. By focusing on these three recurring activities, I have clearly defined parameters for analyzing language use during feedback.

The first activity, number talk, was held about once per week, and was a short mini-lesson in which students solved an arithmetical problem using mental math. Number talks were initiated by posing a problem on the white board. Students would indicate that they had a solution and a strategy to share by holding up a finger. Students were encouraged to find more than one strategy and indicate by holding up additional fingers for each strategy. When most of the students had at least one strategy, students were chosen to share the strategy with the class. I would record each step in the strategy on the white board, ensuring that each step was clearly articulated. If a step seemed interesting or non-obvious, I might have asked another student to state the step in their own words. After several strategies were documented, one was chosen to focus on with the understanding that everyone would use that strategy for the next problem. The goals of number talks were to practice explaining and justifying strategies, to listen to a peer to be able to interpret and use multiple strategies, and build a repertoire of strategies to increase mathematical flexibility. Feedback opportunities occur during the times that students are explaining their strategies.

The second activity is the opening problem that students work on every day at the beginning of class. When students enter the classroom, they begin work on a problem written or projected on the white board. When the majority of students are finished, we engage in a whole class discussion to explore the problem. Students propose solutions and justify their reasoning, while other students are allowed to ask questions or disagree with the strategy used. All solutions are recorded and discussed to reveal any misconceptions or misunderstandings, and I often asked students to repeat a strategy in their own words. The goals of this class discussion were to practice using justification, to practice listening to peers and understanding their thinking, and to reveal any misconceptions about the specific problem being solved. Feedback opportunities occurred frequently during the whole class discussion because multiple students offered ideas and each of these was an opportunity to provide feedback.

The third activity is individual and pair work. In this math support class, homework was not assigned because students received math homework from their primary math class. Therefore, on most days, students were assigned work to do in class, either individually, or with a pair partner. This in-class work usually followed a short exploration in which students were introduced to new material. While students were working, I moved about the class, observing student work, answering questions, and sometimes bringing the class to attention for a quick discussion if some interesting idea or misconception arose. Opportunities for feedback occurred during the entire portion of the activity as I moved about the class checking in on student progress.

I used a mixed-methods approach, collecting both quantitative and qualitative data. The quantitative data consists of student surveys that measure students' perceptions of mathematics, their self-concept regarding mathematics, and their disposition toward mathematical challenges and setbacks. The qualitative data consists of student interviews, video recordings, and a research journal. Table 2, at the end of this section, shows how each data collection technique was used for data analysis.

Student Surveys

In order to establish a baseline of students' dispositions toward mathematics, two student surveys were given during the first week of class. The first survey used a combination of Likert scales and either/or questions to record student dispositions toward mathematics, including the relevance of math to their lives, whether they perceived math as about memorization or thinking, whether they perceived math as cooperative or competitive, and how they thought about making mistakes when doing math. The second survey is a mindset survey modified for students age 12 and above (Dweck, 2000, p. 177). The mindset survey was given again during week 15 and used for comparison with baselines. Data from the surveys was examined to understand how students perceived themselves as mathematicians, and to note any difference in students' perceptions of their intelligence as changeable.

Student Interviews

During weeks 8 and 15, interviews were held during lunch with three students. The purpose of the interviews was to explore, in an open and informal way, how students felt about engaging mathematical challenges and learning from setbacks. The interviews were semi-structured with specific open-ended questions and space for students to reflect and elaborate. The final interviews included specific questions about how the students thought about math when they started the year compared with how they thought about math at the end of the quarter. The interviews provided a picture of how the students see themselves as math learners and allowed me to make comparisons with my own perceptions of their dispositions toward math. Student interview questions are listed in Appendix C.

Research Journal

I kept a research journal in which I recorded reflections about how I saw my own use of language in the class and also reflections about specific students. The journal entries served two purposes. First, they represented a record of my change and growth as a teacher learning to use specific kinds of language and interactions with students which I hoped to make a permanent part of my practice. Second, they constituted qualitative data about my perceptions of students over time. These perceptions of students documented how students were changing and how their relationship with me was changing. This story is important because it provided triangulation with the student interviews and allowed me to compare my perceptions of student dispositions with the students' own statements about their dispositions.

Video Recording

I videotaped one class each week during weeks 5, 6, and 7, and then again during weeks 13 and 14 for a total of five classes. The first three recordings were of the entire class, making it more difficult to perceive my individual interactions with students. During the final two weeks, I decided to focus the recording on a smaller group of students which included all three of the interviewed students. While this prevented me from seeing the larger class interactions, it allowed me to see a much more detailed view of my language use with individual students.

The purpose of these recordings was to provide evidence of my use of language when giving feedback to students. The recordings were coded in order to count examples of feedback oriented either toward a student or toward a student's effort. During analysis, a third category emerged for feedback that was positive but could be classified as neither person-oriented nor effort-oriented. I called this third category "confirmatory statements." Video coding categories are listed in Appendix D.

This coding served two purposes. First, it demonstrated whether or not I was using effort-oriented language, for the purposes of drawing conclusions about how student dispositions were affected. Second, the coding provided a record of which students received feedback, which allowed me to more effectively draw conclusions about the effects of my feedback.

Table 2

Data Collection and Analysis Matrix

Purpose of Data	Data Source	*Possible* Methods of Analysis or Coding
Student Disposition	Student Surveys	Baseline dispositions and mindsets. Final dispositions and mindsets for comparison.
	Research Journal	Teacher perspective of ongoing student dispositions
	Student Interviews	Student perspectives on dispositions. "I used to… but now I" statements
Teacher Feedback	Video Recordings	Coding for examples of feedback directed at students and at students' effort. Counting number of times students receive feedback of each type.
	Research Journal	Reflections on use of language and orientation of feedback

Data Analysis

These data sources helped me understand the ways in which my use of specific kinds of feedback affected student dispositions toward mathematics. In my literature review, I noted that feedback that is oriented to effort and strategy leads to an increase in student motivation toward accepting challenges, a reliance on effort rather than ability, and a mastery-oriented response to setbacks instead of a helpless-oriented response. The student surveys, student interviews, and research journal provided a rich, triangulated, qualitative picture of student dispositions toward engaging mathematical challenges and learning from setbacks. This picture emerged when student reflections about math, gathered during interviews, were compared with their original and final survey data and with my own research journal reflections.

In order to make sense of the student mindset surveys (see Appendix A), I calculated raw scores both for the growth-oriented questions and the fixed-oriented questions. Since both sets of questions use the same Likert scale, I calculated a final mindset number by subtracting the fixed score from 21 (inverting the score to make it a growth score) and added this to the growth score. The result was single mindset score ranging from 6 (most growth) to 36 (most fixed) with a median of 21 (most inconclusive). This arrangement of calculations allowed me to consider and compare specific questions, fixed and growth scores, and total scores between the initial and final surveys. A number of students answered this survey in apparently contradictory ways, resulting in total scores that were very close to the midpoint of 21. Eleven students completed both the initial and final mindset surveys.

The disposition surveys (see Appendix B) were first analyzed to look for patterns of questions that could be grouped together. The survey contained twenty-six questions and it did not make sense to try to use each question as a separate variable when describing the students. As I considered patterns in the questions, an initial grouping of five categories of disposition emerged: was math enjoyable, was math relevant, was math a cooperative or competitive endeavor, was math about thinking or memorizing, and was about taking risks. It then became apparent that these five dispositional categories seemed to be addressing two more general questions: Is math a worthwhile subject to study, and what does it mean to do math. These two general questions became the top-level categories for analyzing student dispositions towards math while the five dispositional categories allowed for more nuanced descriptions. The coding schema for the disposition surveys is listed in Appendix B.

The research journal and video recordings provided a triangulated picture of how feedback was directed at students. The journal contained my own reflections on my use of language and how my feedback was oriented. The video was originally coded for two categories of language use: oriented to the student, and oriented to the strategy and effort.

However, a third category emerged during analysis, because there were word phrases that seemed to fall in between. These were phrases like "yes" or "good," and it was not clear that these belonged in either of the two categories. I decided to create a third category to contain these more neutral, confirmatory statements. By coding the video for different types of feedback, student-oriented and effort-oriented, I could draw stronger conclusions about my actual use of feedback and also document which students received which type of feedback. An additional analysis from the video recordings revealed the ways in which my feedback changed over the course of the study. This led to an additional finding about my awareness of language use in the classroom and how that awareness led me to make changes.

Together, these analyses helped me understand the impact of effort-oriented feedback on student disposition toward mathematics. By comparing the coded data about two types of feedback with student interviews, I could explore the effect of my feedback on my students' dispositions. A concern during this analysis was the degree to which I, as both researcher and practitioner, may have changed my practice over the course of data collection. This concern will be explored in the next section.

I borrowed analytic practices from grounded theory paradigm in coding and analyzing my data. The goal of grounded theory is to allow patterns to emerge from the data, rather than beginning with a hypothesis about what is expected to happen. While it was tempting to begin with the expectation that student dispositions would improve through the use of feedback, I was more interested in the qualitative picture that emerged during my work with students. This picture has more interesting consequences for my practice. Rather than drawing a single conclusion about feedback, I am able to draw on the myriad experiences of my students and on my own reflections to think about how I would like my practice to evolve.

Limitations of the Study

Over the summer prior to the school year, the school district decided to explore using mindset as a tool in the math support classes, including the one in which I taught. The result was that my students watched five videos that introduced two ideas intended to improve students' dispositions toward math: first, that anybody can do math; second, that the way students think about how smart they are at math - in effect, their math mindset - impacts their ability to get better at math. These videos create a potential limitation to the credibility of this study because they might have affected student dispositions in a way that was similar to the ways in which teacher feedback might have affected them. Transferability is also impacted, because the videos are a somewhat unusual addition to a math classroom. However, because the video series is made freely available by Stanford University, it is certainly possible to use them in other classes. It is of interest that one of the three interview students, Emily, was not present to view the videos, and this student had the most significant change in mindset in the class.

Data collected from the students are in the form of two different surveys and student interviews. These are potential limitations to credibility because students could have simply answered the way they thought I wanted them to answer, or in ways they thought might make them look better. To increase the credibility of the surveys, students were instructed that there were no correct or incorrect answers, but rather that different people simply thought differently about intelligence and math. Additionally, Dweck's mindset survey has a very high internal consistency with a Cronbach alpha $\alpha > .90$ (Dweck, 2000).

The interviews were semi-structured so that students were given an open-ended question (see Appendix A) and then allowed to talk at length. To increase credibility, the questions were similar in nature for both sets of interviews, although the final interviews asked students to consider changes in how they felt compared to the start of the school year. An informal review by a colleague of the interview transcripts did raise the possibility that I occasionally used affirming language (e.g. saying "ok, good" instead of simply "ok"). This might have led students to hear that certain kinds of answers were preferable.

This study's dependability is limited because the research from my literature review concerning the use of effort-oriented feedback was conducted by psychologists. My background in the actual practice of using effort-oriented feedback is much more limited, and so my results might be quite different. This limitation is mitigated because Rattan, Good, and Dweck (2012), found that teachers who held an incremental theory about intelligence tended to also use feedback that was oriented toward effort and strategy. Because I, the teacher, hold an incremental theory of intelligence, my feedback to students should tend towards their effort and strategy, and this tendency will be measured against video recordings of the classroom proceedings.

There are other limitations to the transferability of this study. The study was limited to a single class of transitioning sixth-grade students, so the sample size was small. Additionally, the class was homogeneous in the sense that all the students were struggling with mathematics. This makes it difficult to transfer conclusions, even to other math classrooms. However, because all the students are struggling, it might actually increase transferability to other math support classes. Finally, the evolving nature of my own feedback to students, mentioned previously, makes it difficult to transfer to other practitioners because their language would likely evolve in a different manner. However, this change in feedback actually informs my own future practice and this will be discussed in the next section.

CHAPTER 3: FINDINGS

Introduction

This action research project asked the following question: When the teacher implements feedback and praise that is directed at students' efforts and strategies, what is the effect on students' dispositions toward challenges and setbacks in middle school mathematics? Two themes emerged during data analysis, one regarding teachers' use of language, and the other regarding students' dispositions towards mathematics. Each of these two themes resulted in a single finding.

The theme regarding use of language emerged from analysis of the classroom video recordings and led to the first finding: the use of specific teacher language requires specific supports. That is, the feedback and praise that I intended to use as part of this research didn't occur until I began to add support for language use in my lesson planning. This theme emerged during initial analysis of classroom video recordings, beginning in week 5, and was a critical first factor in changing the focus of my research from how language affects an entire classroom to how it affects specific students.

The second theme emerged during analysis of student surveys, student interviews, and notes from my research journal. This theme involved student dispositions towards challenges, setbacks, and towards math in general. It led to the finding that students' dispositions toward setbacks and challenges improved. Emily and0 Maggie both showed significant improvement in their response to setbacks and their interest in attempting challenging problems. However, it remains unclear to what extent this finding can be correlated with the use of feedback and praise, and this will be explored in more detail.

The second theme, in particular, became significant after the initial student interviews, during week eight, when the students expressed their dispositions towards mathematics in their own words. After these initial interviews, the research began to change, from a context primarily about a teacher and a classroom, to a context involving a teacher and specific students. In other words, my focus as a researcher changed from the dispositions of an entire classroom of students, to the dispositions of the three interview students, Emily, Luci, and Maggie.

This chapter presents analysis of each data source before proceeding to a more detailed description of the findings. In order to support a finding about student disposition, it is necessary to draw from survey and interview analysis. Both of these data sources are explored in detail, followed by a more thorough statement of findings and limitations.

Survey Results

Two surveys were given during the first week of class. The first was a mathematics disposition survey that asked students about their perceptions of what mathematics is and what it means to do math. The second was a mindset survey, created by Carol Dweck (2000), which uses a Likert scale to assess tendencies towards both fixed and growth mindsets. Emily joined the classroom during the third week of school and was administered both surveys during week three.

Analysis of the Disposition Survey

During the first week of the school year, students were given a math survey to record various aspects of their disposition towards mathematics. Nine students completed the survey including all three of the interview students. The surveys were coded in order to understand five questions about math falling into two categories of student disposition (see Appendix B for the survey questions and coding schema):

- Is math a worthwhile subject to study?
    - Do students consider mathematics to be relevant to their lives?
    - Do students enjoy mathematics?
- What does it mean to do math?
    - Do students think learning math is more about thinking or memorizing?
    - Do students think learning math is more cooperative or competitive?
    - Are students willing to take risks in a math class?

Students were almost universal in believing that math was relevant to their lives, and all but two students believed that math was about things that happen in the real world. The only deviation was Emily, who thought that math was important in the future, but strongly disagreed that math was useful. All nine students except for Emily seem to enjoy some aspect of math, although except for Luci they also thought that other subjects were more interesting. Students all claimed to try hard to learn because they want a good grade, but many also said they try hard because they want to learn something new. Students were mixed on whether they enjoy math when it requires deep thinking, but almost all did not enjoy math when they don't have to work at it. This might indicate that students tended to enjoy math when it was challenging but not frustrating. Maggie showed an unusual (for this class) disposition by expressing dislike for hard work but enjoying math when it was easy.

When thinking about what it means to do math, the students were universal in thinking that math consisted of procedures to be memorized, and all but three students thought that mathematical success was about memorization rather than about thinking. Luci was the only interview student who thought of math success in terms of thinking rather than memorization. All but one student believed it was important to use the teacher's methods. In terms of risk taking, all students believed that making mistakes was acceptable even when working at the board. However, almost half the class, including Maggie and Luci, thought it was important to avoid looking stupid. These numbers matched closely with a question about trying hard in order to look smart in the eyes of peers. Overall, the students seemed to view math as a cooperative enterprise with only a single student seeming to be much more competitive than cooperative. Emily didn't seem to perceive math as either competitive or cooperative, and this is probably because she indicated not enjoying math at all.

The disposition surveys present a picture of how students thought about math at the beginning of the school year. The class largely thought that math was relevant and somewhat enjoyable, and with the exception of Emily, I found them to be engaged with the material. The students also believed math to be about memorizing procedures learned from the teacher, rather than believing it to be a process of discovery. These dispositions were important considerations for my research in two ways. First, because students thought of math as procedural in nature, I understood that they might be more likely to display a helpless orientation to setbacks if the lessons were about discovery rather than memorization. Second, I expected that Emily in particular might display a helpless orientation because she was the only student who indicated that math was neither useful nor enjoyable. This turned out to be true, and Emily had not earned a passing grade until after the middle of the quarter. This was relevant to the analysis theme of student disposition, because Emily showed significant, positive change in her disposition by the time of the final student interview.

Analysis of the Mindset Survey

During the course of this project, eleven students completed initial and final mindset surveys (see Appendix A). Because the survey independently measured tendencies towards both fixed and growth mindsets, it was possible to be strongly or weakly associated with either. This in fact happened with multiple students, suggesting that these students were neither fixed nor growth oriented. The surveys were given during week 1 and again during week 15, and were coded to calculate three scores (see Appendix A for details):

- a fixed-mindset score ranging from 3 (*strongly fixed*) to 18 (*weakly fixed*)
- a growth-mindset score ranging from 3 (*strongly growth*) to 18 (*weakly growth*)
- a total-mindset score ranging from 6 (*strongly growth*) to 36 (*strongly fixed*), with 21 representing a maximally inconclusive score.

Six students decreased their total mindset scores moving them towards a growth mindset. In particular, the student with the strongest fixed-mindset on the initial survey, Emily, experienced the largest change towards a growth mindset on the final survey. On average, the class experienced a much more modest decrease of only three points per student which means that most students did not change. One student in the class experienced a change towards a more fixed mindset. Table 3 shows initial and final mindset scores for each student.

The mindset survey data was also used to ask some deeper questions about these changes. For example, the survey consisted of three questions that identified with a fixed mindset and three questions that identified with a growth mindset. This addressed the question of whether students who changed tended to change their perspective about fixed or growth orientation. Table 3 shows the fixed, growth and total scores for the eleven students who completed both surveys. Emily, who had the largest change (-20), and Ken, the single student who changed towards fixed mindset, both saw the majority of their change occurring in the growth scores. For these students their change was primarily about how they saw their ability to change their intelligence. On the other hand, four of the six students whose scores decreased towards growth mindset saw the majority of their change in the fixed scores. These students changed primarily in how they perceived their inability to change their intelligence. This is a curious distinction and warrants more investigation.

Overall, the class did not experience much change in their fixed or growth mindset, although many students did see a small change towards a growth mindset. This makes it difficult to draw conclusions about relationships between feedback, mindset, and disposition for the whole class. However, two of the three interview students, Emily and Maggie, had significant changes toward growth mindset. There are several potential explanations for this, but after the sixth week, I made a change to my research to focus feedback and praise more specifically on the three interview students. These changes in mindset are relevant because Dweck (2000) predicts that students with a growth mindset will display a master-oriented response to failure, and will seek challenging tasks rather than easy tasks. I next explore the student interviews of Emily, Luci, and Maggie through their student interviews to draw conclusions about their dispositions towards math.

Table 3

Initial and Final Mindset Scores

Student	Initial Fixed	Initial Growth	Total Mindset	Final Fixed	Final Growth	Total Mindset	Change
Luci	**5**	**6**	**22**	**7**	**8**	**22**	**0**
Emily	**3**	**18**	**36**	**9**	**4**	**16**	**-20**
Maggie	**8**	**5**	**18**	**13**	**4**	**12**	**-6**
Andra	6	5	20	6	5	20	0
Bobby	5	4	20	12	3	12	-8
Danielle	6	6	21	9	6	18	-3
Evan	6	6	21	9	6	18	-3
Ken	3	3	21	3	11	29	8
Kirk	6	5	20	16	9	14	-6
Nicholas	10	9	20	10	9	20	0
Wayne	9	10	22	7	4	18	-4

Note. Individual fixed and growth scores for initial and final mindset surveys. Fixed and growth scores range from 3 (strongly selected) to 18 (strongly unselected). Total mindset score combines growth and fixed producing a score in the range of 6 (most growth oriented) to 36 (most fixed oriented). Change represents the difference in total mindset scores. The three bolded students participated in interviews.

Student Interview Results

Student interviews were conducted during weeks 8 and 15. Emily, Luci, and Maggie were chosen to represent a range of mindsets and dispositions, based on initial survey data. At their request, Luci and Maggie were interviewed together.

Emily

Emily joined the class during the third week, and was administered the mindset and disposition surveys during that week. This student was shy and did not participate in group discussions, never volunteering ideas. Emily initially struggled academically, but by the time of the interview, had become somewhat successful with a passing grade.. However, she did not seem to enjoy math at all. Her initial interview revealed a history of poor math performance, low self-efficacy, and dislike of mathematics.

As mentioned previously, this student was unique in showing a completely fixed mindset on her mindset survey, and as predicted by Dweck (2000), also showed during the initial interview a disposition towards a helpless orientation to failure. Helpless-oriented responses to failure (Hong et al., 1999) include effort withdrawal and persistence with in using a failed strategy. Here is Emily describing what it feels like to fail:

Teacher: What does it feel like when you get a problem wrong, or you do poorly on a test , or you don't understand something?

Emily: When I don't understand something, I get confused, and angry, and I just give up, sometimes, and sometimes I'll go through it if I have help, but usually when I fail a test I usually just act like it's... I know that I know I got it wrong the first time, and I was doing it because I knew that I didn't understand it so I just did what I thought I knew, and I did it… what I thought was right, and I knew that I was probably getting it wrong. Almost every test I take I usually think I get everything wrong.

When Emily doesn't understand a concept, she gets angry and even gives up entirely. Notes from my research journal corroborated this disposition, noting on multiple occasions that Emily was uninterested in participating and frequently stopped working when encountering a difficult problem, instead of asking for help. Later in the same interview, Emily also disclosed a fear of risk taking because other students might laugh. Interestingly, this student seemed to feel safer in the math support class (KEMS), an environment with other students who are also struggling with math.

Teacher: What are your math expectations? What do you… how do you think math is going to go for you this year? Either KEMS or core or both.

Emily: Um, in here I think it's gonna go OK because other people are in here and stuff. I'm always afraid of Mr. J [her core math teacher] because people know what they know more than usually, probably what I know, so every time that he says to raise your hand if you don't know something, I'm always afraid that someone is gonna end up laughing or something, that I got the answer wrong. But in here, I know no one is, because they're going through the same thing I'm going through.

From her disposition survey and from my own classroom observations, Emily did not appear to enjoy math, and seemed to have a very procedural view of what it means to do math. On the other hand, Emily did indicate that math is useful, noting the need to work with money:

Teacher: Do you enjoy math?

Emily: Not really. Um, I've never really liked math or reading. I've… math, it's ok, it can be my favorite, and then it cannot be my favorite. Depends on what we are on. Like fractions we're doing in here, it's ok, some stuff I'll get confused, but I know that I'll end up learning how to do it, and I know that, like sometimes people… well, not people, but sometimes someone will show an example or something and I have to know what I have to do, so… sigh…

Teacher: Do you think math is… do you think it is worthwhile to study math? Is it useful?

Emily: It *is* useful because I'm, like, mom, she buys stuff and I know that she has to watch her limit because she has to pay other bills too, so you have to equal money out and money is the exact thing as math. Like in fractions, we use it when we have to cook, divide things up, and we have to make sure everyone gets the equal amount of piece.

During this time, the students had been working with division of fractions, and the context posed for them was that of equal sharing. I suspect that Emily was seeing a relationship between the sharing problems from class and sharing money across multiple bills. This was not something that I would have noticed about Emily without this interview. I noted the comment near the end of this exchange: "money is the exact thing as math." Emily seemed to have a highly concrete view of what math is and its value seemed to be tied to solving practical problems. Emily's description of math and working with difficult problems seems to correlate with her disposition survey answers, and with her extremely fixed mindset survey score.

When I conducted the final interviews, during week 15, Emily exhibited a much more hopeful disposition towards math. My research journal entries noted that she was an active participant in a group project, and that though she still didn't initiate discussion, she at least participated when the whole class was exploring an idea. Emily's final interview showed a more nuanced view of her relationship with math, including language about both limitations and growth:

Teacher: What do you think about how smart you are at math, compared to the beginning of the year.

Emily: Well, the beginning of the year, I knew I wasn't very good at fractions. Because I never really got, um, to know much about them, just… one of the lessons did it, did a couple of problems, test, and then over with it and the next thing, and now so now here I understand more of fractions and how to like, um, add them, divide them, and stuff like we do, class where we change the denominators to the same denominators, top, and stuff like that... so now I get more of why we do fractions.

The student seemed to acknowledge having improved, at least regarding fractions. However, later in the interview, Emily expressed a complicated mix of fixed and growth ideas.

Teacher: How do you think about being good at math versus getting get good at math?

Emily: Some people are really good at math, and some people aren't. Um, I... I'm more… I wanna get good at math. I actually get it more, like a fun thing.

Teacher: Do you think that slow [*taking longer for a math task*] has anything to do with being good at math?

Emily: No, but I just know that, if someone gives you an amount of time to do something, I'm gonna use a little more longer time to do it. So like, we have a test in Mr. J's class, he can do it faster than I can, and the other people can do it… well, will have a longer time, but for me, it's like division. I take little longer time with that, than the others, so when I do that, I have to do step by step, a little longer than other people do, because they know how many times something goes into something.

Teacher: So, I'm curious, you said earlier, that some people are good at math. Do you think you are?

Emily: They're not… so like, I'm not good at that. I just don't get it. And some fractions that we're doing in that class, I don't get it either. Like, and then some stuff I do get because it's like I know that now because I just learned it, so after a while even though I've like, I had a test not too long ago for, to go to another one, to another lesson, I didn't do good at that test because I didn't understand what half of it was asking and like ratios, and how much time and everything.. So I don't get that, but like, stuff like we are doing in Mr. J, where it's a whole number and then a fraction divided by a whole number and a fraction, I get that now, but at first I didn't, I got frustrated… now I know… So now I know a fraction divided by a fraction… so now, I… it gets a little easier.

Teacher: So, are you better at math than you were at the beginning of this year?

Emily: Um, hmm. Well, usually, if every lesson, like ratios and fractions, um, at first I didn't understand ratios… what that word meant… when we took the test at the beginning of the year, I didn't have any clue so I just basically guessed on everything, but after a while he, teached, I undstanded it a little more, and same with fractions. Every time I go a step further I learn more and more about what they… about what to do with them.

Teacher: What do you think about you doing math in the future. Like seventh, eighth grade, high school, even college, do you think?

Emily: I know, later on I'm gonna end up doing, like… algebra, more harder division… decimals, and fractions, and stuff like that. So, a little higher than what I am right now and little harder.

Teacher: Do you think you can learn that?

Emily: Well, if I can learn what ratios are and fractions, I'm pretty sure I can learn algebra and everything else.

This exchange suggested to me that Emily was wrestling with what it means to engage with mathematics. There was still a fixed mindset present in the statement, "Some people are really good at math, and some people aren't," and this student still harbored a doubt about her ability, stating "I'm not good at that. I just don't get it." On the other hand, Emily didn't seem to associate being slow at math with being bad at math, and, most hopeful of all, while this student began with answers that tended to be negative, she ended with more positive statements, such as "it gets easier and easier" and "every time I go a step further, I learn more and more." Emily's confidence seemed to have increased as she acknowledged both current improvement and the possibility of future success with math.

Emily began the year with a negative disposition towards math and with an extremely fixed mindset, as measured by her surveys. Fixed mindsets correlate with a helpless-oriented response to failure (Hong et al., 1999; Dweck, 2000), and Emily's initial student interview did indicate this response. Hong et al. (1999) also associates growth mindset with a mastery-oriented response to failure, characterized by increased effort and trying new strategies. Emily doesn't explicitly mention either of these in her final interview; however, language about getting angry and giving up is completely absent from the final interview. Emily's final mindset score indicated a modest growth mindset and her interview responses suggested that she has improved her confidence working with math, and that her responses to failure had become much less helpless-oriented.

Maggie and Luci

Luci was a bright, engaging, and confident math student, even expressing surprise at being placed in the math support class. This student was outgoing and always offered ideas during class discussions. Luci was frequently the first or second student to finish assigned work, and often asked for extra math to work on. Maggie began the year presenting a very shy demeanor and struggled academically. She never offered ideas during class conversation, though often had good ideas when directly called on to speak. By the time of the initial interviews, however, Maggie had become a little more outgoing, occasionally offering ideas, and consistently doing average work. In the following exchange, both students talked about their disposition towards math.

Luci: But what confuses me… that math is my favorite subject, and it's like confusing like to my mom too, like how am I in math support. Like, I… math was my favorite subject in elementary.

Maggie: My favorite subject was science.

Teacher: Were you both good at math, would you say, last year?

Both: Yes. [*simultaneously*]

Maggie: I was OK. I wasn't like other people that could just do it like that, really fast.

Teacher: Tell me how confident you are in math.

Maggie: I've been a little more confident in math with math support group because there's not a lot of many people here and they like, get you, they're at the same level with you, but it also can be hard because some people are shouting out and like you start getting confused and you're like what? I don't get this anymore.

Luci: Yeah, I agree. Like, when one person thinks it's ok to shout it out, like the whole class thinks it's ok to shout, like, the answer. And, like when correcting the Do Now, like every one, we're trying to say the answer, everyone's like what? Like, especially when I say the answer, they're like what? It makes me embarrassed when I want to say… like when I feel like I want to say I got the wrong answer, so I feel really embarrassed.

Two aspects were interesting in this exchange. First, Maggie recognized an increase in mathematical confidence, due at least in part to being in a class with other math support students. However, she also qualified her initial agreement about begin good at math by noting that she wasn't like other people that were fast. Second, I was surprised to hear Luci mention feeling embarrassed. Based on my observations and journal notes, this was something I would have guessed Emily and Maggie might be feeling sometimes, but Luci was visibly one of the most confident students in the class.

During the final interviews, we talked about how the students thought about math at the beginning of the year compared to how they thought later. I was interested in whether the students could verbalize any changes in their disposition towards mathematics.

Teacher: I'm going to revisit the question of how math has been this year, and I'm interested mostly in how do you think you felt at the beginning compared to now? So, maybe I'll just ask that in general, then ask more specifically.

Luci: Um, it felt like confusing at first, the first of the year, but when we like, get more into it and you are like, teaching us more about it, I'm like, understanding more and more and like, getting the work done faster and faster.

Maggie: I agree with her because at the beginning of the year, we didn't understand anything because we have both math classes together, we didn't understand anything because it was all numbers. We didn't know what ratios meant, and like we were kind of rusty on fractions, so we didn't really know... but ever since you helped us with it, it's been getting better. Our work has been faster and we learned some new methods and strategies.

It was interesting to hear both students make similar statements about feeling confused at the beginning of the year. Luci exhibited such high confidence that she never appeared confused. In contrast, Maggie frequently seemed to be confused, and her academic performance indicated as much. I next wanted to know if their perception of being smart at math had changed:

Teacher: Compared to the beginning of the year, what did you think about how smart at math you are?

Maggie: Well, I thought I was kind of dumb with math, yeah, it's like I didn't really understand some of it... pretty much most of it. But ever since you taught… made us saw that video about you're not dumb, you're not born smart, you choose to be smart. Your brain will always grow and stuff. Like, you'll never be dumb, you'll always keep growing and stuff like that. So it kind of inspired me to try a little bit harder.

Luci: Well, I was kind of like forgetting math because it was summer and now it's like a fresh new start to memorize, your brain, and get your brain started… but yeah, when we saw the video and what those people say, it like, refreshens my brain like, I don't forget the math that I'm working with and stuff.

I was surprised at Maggie's mention of the mindset videos we watched during week 2, and she indicated that they helped her think about getting better by trying harder. A bit later in the interview, Maggie again referred to the mindset videos. I was surprised at the amount of detail she was able to remember about the video:

Maggie: Like, when a taxi… in the video, when a taxi driver has to learn all the streets in like, London, they have to learn all these streets and where to go and etc. and it takes them four years just to be a taxi driver, because you have to learn all the streets and where they are and memorize it, but when they stop being cab drivers, like, their brain, like, the back of their brain starts to unswell up and it starts

> getting smaller, so that kind of shows like if we learn something about like a bit subject and you memorize it completely, but when you stop doing it then it shrinks down then you get rusty or you make mistakes.

Maggie's descriptions of the mindset videos made me realize that they had made an impact on her thinking. By the time of the initial interviews, Maggie had already begun doing better work and earning a better grade. By the time of the final interview, she had begun to do work almost as strong as Luci's, and her confidence seemed to be as high as Luci's.

Luci began the school year as a confident, competent math student who had had a lot of success in elementary school. Over the course of our time together, this student remained confident, participated in group projects and class discussions, and continued to enjoy math. Her disposition was very positive towards math, and she perceived it to be more about thinking than about memorizing. Luci's mindset survey scores changed slightly, but left her with an identical total score which fell evenly between fixed and growth mindset. Her disposition towards math did not seem to have changed at all, as she remained confident and engaged, and earned the top grade in the class. It is difficult to draw any conclusions about Luci because nothing seemed to have changed for her. She began and ended the term as an extremely confident, capable math student.

Maggie, by contrast, experienced something of a transformation. At the start of the year, she lacked confidence and never offered ideas. By the time of the final interview, Maggie was highly confident, highly motivated, and participated in all activities. She seemed to have particularly been impacted by the mindset videos that we viewed during week two, not only because they were mentioned twice in the final interview, but also because she had embraced the idea that students are not dumb at math. This student directly stated, "it kind of inspired me to try a little harder."

Maggie, like Emily, experienced a significant change in mindset, in fact ending with the most growth-oriented mindset in the class. Hong et al. (1999) and Dweck (2000) correlate a growth mindset with a mastery-oriented response to failure. Maggie clearly articulates this in her final interview when she mentions being inspired to try harder. Both Maggie, and to a lesser extent Emily, showed mindsets and dispositions that are correlated in the literature, and in in exploring findings for this research, I now return to the issue of teacher feedback and praise.

Findings

This action research project asked the following question: When the teacher implements feedback and praise that is directed at students' efforts and strategies, what is the effect on students' dispositions toward challenges and setbacks in middle school mathematics? The first finding emerged from analysis of the classroom video recordings. This analysis occurred during the time I was teaching and became a critical factor in changing my research focus from an entire classroom to specific students.

Teacher Language Required Specific Supports

Analysis of the first two video recordings occurred prior to week seven recording, so I was able to incorporate changes for the third and final full-class recording during week seven. According to the video evidence, during weeks five and six I was not using any specific language directed at student effort and strategies. There were many examples of phrases such as "good" and "yes," but I coded these as belonging to a category of confirmation, rather than a category of strategy and effort. This was surprising because I had assumed that my previous exposure to the work of Carol Dweck and others would have prepared me to use strategy and effort feedback with students. On the other hand, I did not observe any examples of using feedback and praise directed at students' person. Dweck (2000) notes that feedback and praise directed at a person can shift that person towards an entity perspective (fixed mindset). It appears that my exposure to Dweck's work might at least have helped me avoid using language that would promote fixed mindsets in my students.

During week seven, I incorporated specific supports into my lesson planning for the purposes of increasing my feedback directed at student effort and strategies. These lesson-plan supports were as simple as inserting the phrase "use strategy feedback" and "use effort feedback" into my planning template. The phrases were inserted into sections where I guessed that it would make the most sense for that particular kind of feedback. So, for example, the number-talk format was all about students developing strategies, and that was a place in my lesson plan to include a note about using strategy feedback. I was not sure that simply adding phrases to my lesson plans would produce any changes in my language use, so I adopted the habit of rereading the lesson plan during my planning period, which occurred before the math support class.

The video recording from week seven showed two specific examples of language directed at student effort and strategies. Confirming types of statements decreased slightly, suggesting that with the language supports included in lesson plans, I had begun to shift some of my more neutral language into strategy and effort feedback. For example, a phrase that I used from week seven was "well reasoned," and that may have been aplace where I would have said, "good." My journal notes also suggest that I had become more aware of language use, because I began trying to record examples of strategy and effort feedback that I had used. One journal entry recalls an administrative observation that occurred during week 10. The observer was knowledgeable about mindset and familiar with Carol Dweck's work, and provided me with feedback that confirmed my use of language oriented to students' effort and strategies.

The final two video recordings were made of a smaller group of students seated near the front corner of the classroom. All three interview students were included in these recordings. The new recording strategy was initiated because of two factors. First, I had noticed that my strategy-based feedback had increased during week seven, but it was primarily directed at students who volunteered ideas, meaning that only a few students received this kind of feedback. I wondered how I might direct strategy-based feedback to other students. Second, the initial student interviews, conducted during week eight, created an opportunity to use language that was focused on these students, with the benefit that they would be interviewed again several weeks later. During weeks 10 and 11, I began to implement student-based language supports into my lesson plans, meaning that I inserted reminders to use specific language with specific students.

Analysis of the recordings from weeks 13 and 14 showed increased use of language directed at students' effort and strategy, with four and five instances of strategy- and effort-based feedback respectively. Additionally, this feedback was distributed to the three interview students, all of whom I had mentioned in my lesson plans. Confirmatory language did not seem to decrease, suggesting that I was simply directing more total language at these students. Based on the increased amount of feedback, this strategy of using lesson-plan supports to increase the use of feedback directed at effort and strategy appears to have been most effective when used to direct feedback to specific students.

By adding lesson plan support for feedback targeting specific students' effort and strategies, I was able to find classroom examples of the kind of language that I wanted to better understand. Additionally, Emily and Maggie both experienced significant improvement to their disposition towards math and their response to failure. This picture is complicated by the fact that Maggie had begun showing improvement by the time of the initial student interviews, and this is a possible limitation of this research. However, both Maggie and Emily showed improvements between the initial and final interviews.

Student Dispositions Towards Mathematics Improved

The second finding emerged from analysis of the surveys and interviews, and was further validated by research journal notes. The interview students, particularly Emily and Maggie, improved their response to failure, their academic performance, and their engagement with both the material and the other math students. Luci showed these traits from the beginning of the year and continued her strong performance.

The disposition survey provided a picture of how the students viewed math at the beginning of the year. Analysis of this survey suggested a group of students who were mostly positive about math, but who perceived math to be about memorizing and learning the teacher's strategies. Luci had the most positive disposition, believing that math was about thinking and not memorizing, and stating that math was her favorite subject. Maggie had a more mixed disposition, believing math to be useful, and finding some enjoyment. Emily had a decidedly negative disposition, finding no enjoyment of math, fearing embarrassment, and like many of the students, valuing hard work in order to get a good grade.

The mindset survey analysis provides a before and after picture of how students viewed their ability to grow their intelligence. Overall, the class experienced a small change toward growth mindset. Luci had no change remaining with mindset neither growth nor fixed. Maggie showed a change to a much stronger growth mindset. Emily had the largest change in the class toward growth mindset changing from the highest possible fixed mindset to a moderate growth mindset. Drawing from the existing research presented in the literature review (Dweck, 2000; Good, Rattan, & Dweck, 2012), these changes in mindset predict an improved disposition towards math, including improved response to failure, improved academic performance, and increased sense of belonging.

The student interviews allowed the students much more freedom to describe their relationship with mathematics. They also provided pictures of students' perceptions of math from two distinct moments nearly two months apart. Although Luci showed a neutral mindset, she had the most positive things to say about math in both initial and final interviews. Luci performed at or near the top of the class academically for the entire quarter, but showed a mixed response to failure. Journal notes about this student documented times when this student would try harder, and other times when this student would give up in frustration.

Emily experienced a significant, positive shift in disposition towards math. In her initial interview, this student talked about becoming confused and angry after experiencing failure, and having a sense that the work that she did when testing was wrong. Journal notes documented that this student gave up in frustration when experiencing difficulty. During the final interview, Emily still expressed negative statements about math, but each one was followed up with a positive statement. A statement about not being good at fractions was followed by a statement about being better at fractions. A statement about being bad at math was followed by one stating a desire to get better at math and that it was more fun. Research journal notes corroborate this change in disposition. During the last weeks, Emily was more likely to ask for help, actively participated in a group project, and improved academically to be in the top quarter of the class.

Maggie also experienced a significant improvement in disposition towards math, particularly compared to the beginning of the year. Maggie began the year as one of the most shy, least likely to participate, and seemingly least engaged students in the class. By the time of the first interview, Maggie had become more engaged, and during the interview, specifically mentioned her increased confidence because of being in a class with other struggling math students. By the end of the project, Maggie had become one of the top students in the class. Her grade had improved to be in the top quarter of the class, and her participation, both in risk taking and in asking questions, had improved dramatically. Research journal notes showed that she always participated in more advanced challenges when her work was done, something predicted to correlate with a growth mindset (Dweck, 2000). During the final interview, Maggie noted that at the beginning of the year she had thought she "was kind of dumb with math," but that now she knew that because of brain growth, "you'll never be dumb, you'll always keep growing."

Over the duration of this research, the dispositions of two of the three interview students, Emily and Maggie, improved substantially. During the same period of time, my use of feedback directed at effort and strategy changed from rarely occurring, to frequently occurring and directed at specific students. It is tempting to postulate that my use of feedback directed at strategy and effort was a cause of the students' changes in disposition and that these changes were mediated by changes in their mindset. Dweck (2000) demonstrates that feedback directed at strategy and effort will effect a change towards a growth mindset. Hong et al. (1999) and Dweck (2000) associate a growth mindset with improved disposition including mastery-oriented response to failure, higher engagement, and choosing higher challenges rather than lower challenges. Emily and Maggie both saw a change towards growth mindset and both saw improvement in their dispositions towards math. The existing literature suggests that the feedback I used could be at least partly responsible for their improvements.

Limitations and Implications for Future Research

There are two issues that limit the credibility and dependability of this study, and they stem from Maggie's changes over the term. First, Maggie had shown some improvement by the time of the first student interviews, which was only one week after I had begun to see evidence of using strategy-based feedback. It seems more likely that other factors had begun to change her disposition, if not her mindset, prior to receiving effort and strategy based feedback from me. It is true that by the time of the final student interviews, Maggie's mindset survey showed a strong growth mindset compared to her initial mindset, and her disposition towards math had significantly improved; she took more risks, attempted more challenging work, and showed a positive response to failure. However, it is difficult to attribute her growth specifically to the type of feedback that I directed towards her.

The second limiting factor is that early in the term, this class viewed several video presentations specifically designed to improve students' dispositions towards math by inducing a growth mindset. Both Maggie and Luci mentioned these videos in their final interview, and this again limits both the credibility and dependability of this research. Emily provides a contrasting picture, however, as she did not see the videos. Emily also experienced a significant change towards a growth mindset, in fact, the largest change in the class. Her disposition also improved, though not so dramatically as Maggie's did. However, Emily's disposition improved significantly between initial and final interviews. Both credibility and dependability are strengthened by the fact that Emily's changes were due to factors other than the mindset videos, and because her changes occurred during the time frame during which I had begun using student-targeted, strategy- and effort-based feedback.

I found that adding specific language supports to my lesson plans increased the likelihood that I would use feedback oriented toward student strategies and effort. Additionally, it appeared that the most effective use of those planning supports was when they were directed at specific students. One implication of this study is that it is a worthwhile practice to include these language supports in lesson plans, particularly as part of an intervention for specific students. Doing so would likely increase the amount of direct, strategy- and effort-based feedback these students received.

The larger question remains, however, as to whether the use of strategy- and effort-based feedback caused the students in this study to adopt a growth mindset. The dependability of this research is strengthened because the literature certainly suggests this, particularly Dweck (2000, 2008). Two of the three students interviewed for this research changed toward a growth mindset, and both clearly improved their dispositions towards math, which is predicted by existing research (Blackwell, Trzesniewski, & Dweck, 2007; Good, Rattan, & Dweck, 2012; Hong, Chui, Dweck, Lin, & Wan, 1999). It would be unreasonable, however, to conclude that the feedback used in this study was the major cause of students' changes in mindset, or of their improved dispositions, because there are simply too many other variables. Luci and Maggie both mentioned the mindset videos viewed during the second week, so perhaps that was a critical factor. When I began using student-specific feedback, beginning in week 10, perhaps the extra attention received by these students, more than the content of the feedback, was responsible for their changes.

Future action research could address these questions. To more clearly understand some of the variables involved in improved dispositions, researchers could compare different kinds of targeted feedback supports. For example, a study might compare increased strategy-based feedback to selected students with increased neutral feedback to selected students, to see whether the type of feedback or simply increased attention made a difference. The use of mindset videos seemed to be important for at least Maggie, so it would be interesting to know if her disposition would have improved so noticeably if she had not viewed the videos. During the final interviews, one further variable emerged as a possible influence on student dispositions: the interview process itself.

An interesting moment occurred during the final interview with Luci and Maggie. The interview had finished, Luci had got up to leave, and Maggie paused reflectively. When she began to speak, I asked if she would repeat what she said so that I could record it.

Maggie: Ever since we started doing these little interviews, like asking us questions, it's like, opened my mind to a new, entire view about math. So like, what are my problems? What are my expertise about this? Like, when I'm in my fifth period with Miss M, I used to be really shy and I used to get behind in work because I didn't understand what she was asking us. It's kind of made me a little un-less shy, and I've been asking her like, how do I do this? How am I

> supposed to do this? And like, am I doing this right? And yeah, it's kind of helped me… be more better at math… not be shy about it and how I feel about it.

This raises the possibility that the interview process itself was part of the reason this student improved her disposition, and points to a further implication: that student interviews might be a useful strategy for helping students to think differently about math. In a more individualized setting, with an open format to talk about personal experience, this student began to change her relationship with math. The role of student interviews in helping students change their disposition toward math is outside the scope of this research, but it points to possible future research. Specifically, what is the role of the student interview, or similar, individualized format, on student disposition?

Concluding Remarks

This action research project asked the following question: When the teacher implements feedback and praise that is directed at students' efforts and strategies, what is the effect on students' dispositions toward challenges and setbacks in middle school mathematics? The answer to this question seems to be that if one can overcome the challenges of incorporating strategy- and effort-based feedback, particularly for selected students, then those students' dispositions can improve. There are almost certainly multiple variables at play in determining student disposition towards mathematics, but the results of this study are compatible with existing research. Future action research is needed to further isolate strategy- and effort-based feedback as a principle mechanism for improving student disposition toward mathematics.

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APPENDIX A

Mindset Survey

Name:______________________ **School:**______________

Class:__________________

Read each sentence below and then circle the *one* number that shows how mucl you agree with it. There are no right or wrong answers.

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

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

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

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

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

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

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

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

5. You can always greatly change how intelligent you are.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

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

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

Raw scores were calculated both for the fixed-oriented questions (1-3) and the growth-oriented questions (4-6). Since both sets of questions use the same Likert scale, a final mindset value was calculated by subtracting the fixed score from 21 (inverting the score to make it a growth score) and added this to the growth score. The result was single mindset score ranging from 6 (most growth) to 36 (most fixed) with a median of 21 (most inconclusive). This arrangement of calculations allowed me to consider and compare specific questions, fixed and growth scores, and total scores between the initial and final surveys. A number of students answered this survey in apparently contradictory ways, resulting in total scores that were very close to the midpoint of 21.

APPENDIX B

Student Disposition Survey And Coding Schema

1. How much do you agree with these statements about math: (check one box)

	strongly agree	agree	disagree	strongly disagree
Math will be really important in my future career				
Other subjects are more interesting than math				
Math is really useful in life outside of school				
Math is a lot of procedures that have to be memorized				

2. Which of these statements do you agree with MORE: (check one box)

School math is based in things that happen in the world	
OR	
School math is very different from things that happen in real life	

3. Which of these statements do you agree with MORE: (check one box)

Success in math is mainly about memorization	
OR	
Success in math is mainly about thinking for yourself	

4. In math class, how often do you:

	strongly agree	agree	disagree	strongly disagree
Try to help your classmates solve a problem				
Try to learn things because you want to get a good grade				
Try to learn something new even when you don't have to				
Try to get more answers right than your classmates				

5. How much do you agree with these statements about math:
(check one box)

	strongly agree	agree	disagree	strongly disagree
It is important to use the teacher's method				
It's OK to make mistakes in work				
It is important to avoid looking stupid in front of others				
Students are encouraged to try new things				
It is good to make mistakes at the board				

6. I really enjoy math class when:

	strongly agree	agree	disagree	strongly disagree
The problems make me think really hard				
I am the only one who can answer a question				
I don't have to work hard				
The whole class learns together				
I am the first one to get a question right				

7. When I try hard in math it is because:

	strongly agree	agree	disagree	strongly disagree
I want to get a good grade				
The work is interesting				
I want to learn new things				
I want my classmates to think I'm smart				

Coding Categories

Questions were combined in order to answer two top-level questions (top-level categories):

1. Is math a worthwhile subject to study? (Coded below as "Worthwhile")
2. What does it mean to do math? (Coded below as "Doing Math")

Questions were then further sub-categorized as follows:

- Is math a worthwhile subject to study?
    - Do students consider mathematics to be relevant to their lives? (Coded below as "Relevant")
    - Do students enjoy mathematics? (Coded below as "Enjoy")
- What does it mean to do math?
    - Do students think learning math is more about thinking or memorizing? (Coded below as "Memorize")

- Do students think learning math is more cooperative or competitive? (Coded below as "Cooperative")
- Are students willing to take risks in a math class? (Coded below as "Risk")

Coding Schema

Question	Category	Sub-Category
Other subjects are more interesting than math	Worthwhile	Enjoy
Try to learn things because you want to get a good grade	Worthwhile	Enjoy
Try to learn something new even when you don't have to	Worthwhile	Enjoy
The problems make me think really hard	Worthwhile	Enjoy
I don't have to work hard	Worthwhile	Enjoy
I want to get a good grade	Worthwhile	Enjoy
The work is interesting	Worthwhile	Enjoy
I want to learn new things	Worthwhile	Enjoy
Math will be really important in my future career	Worthwhile	Relevant
Math is really useful in life outside of school	Worthwhile	Relevant
School math is based in things that happen in the world	Worthwhile	Relevant
School math is very different from things that happen in real life	Worthwhile	Relevant
Try to help your classmates solve a problem	Doing Math	Cooperate
Try to get more answers right than your classmates	Doing Math	Cooperate
I am the only one who can answer a question	Doing Math	Cooperate
The whole class learns together	Doing Math	Cooperate
I am the first one to get a question right	Doing Math	Cooperate
I want my classmates to think I'm smart	Doing Math	Cooperate
Math is a lot of procedures that have to be memorized	Doing Math	Memorize
Success in math is mainly about memorization	Doing Math	Memorize
Success in math is mainly about thinking for yourself	Doing Math	Memorize
It is important to use the teacher's method	Doing Math	Memorize
It's OK to make mistakes in work	Doing Math	Risk
It is important to avoid looking stupid in front of others	Doing Math	Risk
Students are encouraged to try new things	Doing Math	Risk

APPENDIX C

Student Interview Questions

Week 8 Interview

1. Tell me about your math history.
    a. What was it like last year?
    b. Did you enjoy it?
    c. Were you good at math?
2. How was the transition to middle school?
    a. What has been hard about middle school in general?
    b. What has been hard in your core and kems math classes?
    c. What differences have you seen between math this year and math last year?
3. How has math been this year?
    a. What is it like being in two math classes?
    b. How confident are you with math?
    c. What are your expectations for the KEMS class? What grade do you expect to get?
    d. Do you like math? Do you think it is worth learning?
    e. What would you like to do with math in the future?

Week 15 Interview

1. How has math been this year?
    a. How confident are you with math?
    b. What are your expectations for the KEMS class? What grade do you expect to get?
    c. Do you like math? Do you think it is worth learning?
    d. What would you like to do with math in the future?
2. What are some differences between the start of the year and today?
    a. Differences in your thinking about math?
    b. Differences in your thinking about being smart?
    c. Differences in your thinking about being successful in middle school?

APPENDIX D

Video Recording Coding Categories

Language Category	**Example Phrase**
Confirming Statements	"Yes" "Good" "Nice"
Person-oriented feedback	"You are really good at math" "You are really smart"
Effort- and strategy-oriented feedback	"I like how clearly you explained that" "That was a really good question because…" "Well reasoned" "I see how hard you are working on that – keep going!"