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Shanna N. Ricketts Date

Academic Resilience in Mathematics

By

Shanna N. Ricketts
Doctor of Philosophy
Division of Educational Studies

_____

George Engelhard, Jr., Ph.D.
Co-Advisor

_____

Mei-Lin Chang, Ph.D.
Co-Advisor

_____

Robert J. Jensen, Ed.D.
Committee Member

Accepted:

_____

Lisa A. Tedesco, Ph.D.
Dean of the James T. Laney School of Graduate Studies

_____

Date

Academic Resilience in Mathematics

By

Shanna N. Ricketts
M.B.A., INSEAD, 2008
B.A., Harvard University, 2003

Co-Advisors: George Engelhard, Jr., Ph.D. & Mei-Lin Chang, Ph.D.

An abstract of a dissertation submitted to the Faculty of the James T. Laney School of Graduate Studies of Emory University in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Division of Educational Studies
2015

Abstract

Academic Resilience in Mathematics
By Shanna N. Ricketts

Background: Resilience has typically been identified based on an outcome-based perspective. That is, certain criteria are chosen by which resilience is identified. These criteria include a measure of risk and a measure of successful outcome. Resilience then is inferred based on the intersection of these two criteria. However, placing the study of resilience within a social cognitive theory framework raises the importance of self-perceptions. Self-perceptions of resilience may give us different information from the outcome-based methods that have dominated the literature.

Purpose: This study expands on the current literature on academic resilience by exploring the construct as measured from the student perspective. Specifically, this study focuses on four guiding questions: 1) What is the relationship between a student's academic resilience as defined from an outcome-based perspective and that student's academic resilience as defined by self-perceptions? 2) Do student self-perceptions of academic resilience mediate the relationship between risk and academic achievement for all students? 3) Do student self-perceptions of academic resilience function differently for students at various levels of risk? 4) What is the role of academic resilience in mediating variables related to mindsets, self-regulated learning, and academic achievement?

Methods: The methods used include Rasch analyses for exploration of the congruence between academic resilience measured based on outcomes and measured based on student perceptions. Hierarchical regression modeling is used to investigate the potentially mediating role of student self-perceptions of academic resilience between risks and academic outcomes. Structural equation modeling is used to explore the potentially mediating role of academic resilience between student mindsets and outcomes. Rasch-based analyses are conducted using the Facets program (Linacre, 2013). Hierarchical regression modeling is performed using the nestreg command in Stata: Release 13 (StataCorp, 2013). Structural equation modeling is performed using LISREL 9.1 (Joreskog & Sorbom, 2012).

Major Findings: Results from the Rasch-based analyses indicate that the two different methods of measuring academic resilience are not congruent. The hierarchical regression models suggest the greater importance that student perceptions of academic resilience play for those students facing risk. The structural equation model highlights the mediating role that academic resilience plays in helping to predict academic success.

Academic Resilience in Mathematics

Shanna N. Ricketts
M.B.A., INSEAD, 2008
A.B., Harvard College, 2003

Committee Members:
Dr. George Engelhard, Jr., Co-Advisor
Dr. Mei-Lin Chang, Co-Advisor
Dr. Robert Jensen

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"No man is an island; no man stands alone" –Dennis Brown

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Chapter One: Introduction

Adolescence is an important time in human development, marking the transitional period from childhood to adulthood. While adolescence is a time period in which positive change can be made, it is also a period of life in which particular behavioral patterns—both good and bad—gain permanence (Crockett & Crouter, 1995). Indeed, some of the decisions that are made during this time period can permanently alter one's life trajectory. As such, the transitional period of middle school is an important time as it coincides with adolescence. It is during this time period that student attitudes and motivations toward mathematics become less amenable to change (Middleton & Spanias, 1999). Yet, it is also at this time that student success in mathematics becomes particularly important as success, or lack thereof, in mathematics in the middle grades greatly influences whether students take higher level mathematics and science courses both in high school and in college (Pajares & Graham, 1999). As mathematics continues to play an important role in both educational and career success (Siegler et al., 2012), it is imperative that adolescents are appropriately supported through the middle school transition in mathematics.

Student beliefs regarding the nature of mathematics seem to be at odds with the beliefs of the nature of mathematics held by mathematicians. Muis (2004) finds that, in general, students hold beliefs about mathematics that have either no influence or a negative influence on learning outcomes. She writes:

> Students typically believe that learning of mathematics should occur quickly, within 5 to 10 minutes. If they have not solved the problem or come up with the correct answer in that time period, students believe they will never be able to

> figure it out either because they are incapable of understanding the problem or because something is wrong with the problem itself. (p. 330)

These beliefs about the nature of mathematics are a cause for concern among mathematics educators because of the potentially negative influence such beliefs can have on learning outcomes in mathematics (Muis, 2004). These beliefs are also not congruent with the actual nature of mathematics. It is not necessarily true that mathematics should be something that comes quickly if one is good at it. Additionally, this belief can be damaging as it discourages persistence in the face of mathematical challenges. Given this context, a focus on academic resilience, particularly in the domain of mathematics, becomes very important. Student ability to recover from failure and handle challenges is particularly important to their success in mathematics. It is this ability on the part of students to recover from failure and to deal with challenges in the domain of mathematics that is the focus of this study. Throughout this dissertation, I refer to this quality as resilience or academic resilience. In this dissertation, I focus on student self-perceptions of academic resilience, adding to the existing literature that has primarily focused on academic resilience based on outcome measures.

Theoretical Framework

Perceptions and beliefs are at the heart of social cognitive theory (SCT). Schunk, Pintrich, & Meece (2002) draw a contrast between behavioral theories and social cognitive theory writing, "In contrast to behavioral theories that stress the consequences of behavior, social cognitive theory contends that individuals act based on their thoughts, goals, beliefs, and values" (p. 122). Bandura (1997) also writes about the power of perceptions stating that "people's level of motivation, affective states, and actions are

based more on what they believe than on what is objectively true" (p. 2). Therefore, in studying academic resilience, perceptions are important. Challenges that seem similar to an external observer may be perceived quite differently by those experiencing the challenge. How a challenge, difficulty or setback is perceived and interpreted by the student is particularly important for understanding how that student is able to deal with that particular setback as "there are significant individual differences in how people respond to disadvantage and risk" (Harvey & Delfabbro, 2004, p. 3). Therefore, while two students may from an outsider's perspective appear to be experiencing the same level of risk, the ways in which they respond can be vastly different, and some of this may be explained by how they perceive the risk that they face and the resources they have to handle the challenge.

SCT provides an agentic explanation for human behavior, disavowing the behavioristic view that things simply happen to the person and the person has no role in creating or affecting such events. As Bandura (1989) writes, "persons are neither autonomous agents nor simply mechanical conveyers of animating environmental influences. Rather they make causal contribution to their own motivation and action within a system of triadic reciprocal causation" (p. 1175). Bandura (1989) posits a reciprocal triadic relationship between person, environment, and behavior. Figure 1 illustrates this relationship incorporating the constructs that are explored throughout this study. Personal factors influence a person's behavior, but behavior also influences personal factors. Similarly, the environment influences a person's behavior, but a person's behavior also influences the environment. Wang, Haertel, & Walberg (1994) write that "children in stressful life circumstances who have an easy temperament are

more likely to receive the social support necessary for surviving adverse life events" (p. 49). The more amiable child may be able to extract more resources from the same environment than a child who is not as amiable. One can think of this situation within a classroom context in which the outgoing child garners more attention from the teacher than the withdrawn child. The reciprocity can be seen in a situation in which the outgoing child having received more attention continues to seek out the teacher and increases their positive interactions, whereas the withdrawn child having been rebuffed or ignored by the teacher becomes more withdrawn and less likely to interact positively with the teacher. Thus, the person, environment, and behavior all interact reciprocally. Situating academic resilience within social cognitive theory allows us to describe the entire ecosystem that allows a student to do well academically even in the face of challenges. Therefore, the focus is not just on personal factors, but also on the type of environment, and the interaction between these that bring about the desired outcome of academic achievement. The personal factors that are explored in this study are the demographic variables of gender and ethnicity, student self-perceptions of academic resilience and the implicit theories of intelligence a student holds, also referred to as mindsets. The behavioral variables include self-regulated learning and academic achievement. The environment is the context within which this study takes place, which is 7th and 8th grade mathematics classrooms.

Statement of the Problem

Current research on resilience is based primarily on outcomes, and tends not to take into account self-perceptions. Under the current popular framework, in order for a person to be categorized as resilient—he or she must face a pre-determined risk criterion

or a number of pre-determined risk criteria and must have surpassed a pre-determined threshold on a measure of success. In the academic resilience literature, studies have typically used low socioeconomic status and minority status as risk factors, and academic achievement as demonstrated by matriculation at college or scoring in the top percentile on a standardized test as the measure of success. Based on the intersection of the risk variable and the measure of success variable, a student is then categorized as resilient. However, the student perspective of risk and level of accomplishment needed for success are not taken into account. Additionally, this type of classification does not lend itself to a proactive view of helping children who may be struggling now. In this framework, it is not possible to identify a student as resilient until after an academic outcome has been achieved, and as a result the ability to put in place potentially helpful interventions is not possible. For these reasons, I argue that a focus on student self-perceptions adds greatly to the literature on academic resilience and provides complementary information to that already existing based on an outcome-based approach.

Purpose of the Study

The purpose of this dissertation is to extend the discussion of academic resilience to include the student perspective. This study situates the study of academic resilience within the theoretical framework of social cognitive theory (SCT; Bandura, 1989). The congruence between academic resilience as measured based on outcomes and as measured based on self-perceptions is explored. The mediating role that academic resilience as measured by student self-perceptions plays between risk and academic outcomes is explored. Finally, academic resilience is placed in the larger structural

framework of beliefs and environment to explore the role it plays in mediating the relationship between beliefs and outcomes.

Research Questions

This dissertation is guided by the following research questions:

1. What is the relationship between a student's academic resilience as defined from an outcome-based perspective and that student's academic resilience as defined by self-perceptions?
2. Do student self-perceptions of academic resilience mediate the relationship between risk and academic achievement for all students?
3. Do student self-perceptions of academic resilience function differently for students at various levels of risk?
4. What is the role of academic resilience in mediating variables related to mindsets, self-regulated learning and academic achievement?

Definitions

The following key terms are used frequently throughout the dissertation:

Academic resilience: Throughout this study there are two different ways to conceptualize academic resilience. See *outcome-based academic resilience* and *self-perceptions of academic resilience*.

Congruence: In the context of this study, this refers to the alignment or misalignment between student categorizations of resilience based on an outcome-based approach and based on self-perceptions.

Implicit theories of intelligence: This refers to the views that a person holds about intelligence. There are two theories that a person can hold: an incremental theory and an entity theory. An incremental theory refers to the belief that intelligence is something that can be changed. An entity theory refers to the belief that intelligence is something that is innate, and thus immutable (Dweck & Leggett, 1988).

Mindsets: See *implicit theories of intelligence*. A fixed mindset is the same as holding an entity theory of intelligence and a growth mindset is the same as holding an incremental theory of intelligence (Dweck, 2006).

Outcome-based academic resilience: This refers to the identification of academic resilience based on the intersection of risk and academic achievement.

Risk: In this study, risk is used to refer to factors that have been shown in prior research to be negatively related to academic achievement.

Self-perceptions of academic resilience: This refers to student ratings of their academic resilience based on the academic resilience in mathematics scale (Ricketts, Engelhard, & Chang, 2015), which refers to their ability to handle challenges to their success in mathematics.

Self-regulated learning: Self-regulated learning typically includes three major components: strategies for monitoring learning, control, and strategy use (Pintrich and De Groot, 1990). In this study, self-regulated learning focuses on the first two using the terms quality and quantity to refer to these aspects respectively. Quality of self-regulated learning asks students about the frequency with which they assessed the process of their learning. Quantity of self-regulated learning asks students about their ability to control their effort (Linnenbrink, 2005).

Overview of Dissertation

Chapter One provides an introduction to the dissertation. This includes the theoretical framework which is used throughout all three studies. It also includes the statement of the problem, the purpose of the study, as well as the specific research questions that undergird this dissertation. Chapter Two includes the literature review. Chapter Three addresses the first research question: What is the relationship between a student's academic resilience as defined from an outcome-based perspective and that student's academic resilience as defined by self-perceptions? This chapter also includes a review of the literature specific to this issue of congruence between the two methods of measuring academic resilience. Chapter Four addresses the following two research questions: Do student self-perceptions of academic resilience mediate the relationship between risk and academic achievement for all students? and Do student self-perceptions of academic resilience function differently for students at various levels of risk? Chapter Five addresses the last research question: What is the role of academic resilience in mediating variables related to mindsets, self-regulated learning and academic achievement? Finally, Chapter Six provides an overall summary of the three studies linking the findings together. This chapter also includes suggested areas for future research as well as a discussion of the implications of this work for research, theory, and practice.

Chapter Two: Review of the Literature

The construct of resilience has its foundations in studies of developmental psychopathology (Masten, Best, & Garmezy, 1990; Masten & Obradovic, 2006). In more recent years, research in resilience has also occurred in fields such as psychology, sociology, and anthropology (Waxman Gray, & Padron, 2003). A focus on resilience represented a shift from focusing on negative outcomes to focusing on positive outcomes even in the face of adverse circumstances. As resilience researchers began to notice that not all children who grew up facing risk became maladjusted adults, there was an impetus to focus on the mechanisms through which some children were able to emerge from challenging backgrounds apparently unscathed. These children were initially called *invulnerables* (Anthony, 1974). Eventually, resilience was used to give voice to the fact that it was not that these children escaped unscathed, but rather that achieving positive outcomes despite challenging circumstances involved some degree of struggle (Waxman, Gray & Padron, 2003). Masten (1994) cautions us that "in our enthusiasm for competence and achievement in people who overcome great risk or adversity, we must be careful not to overlook internal pain or the possibility that extraordinary effort is being expended to sustain competence" (p. 21). The term resilience allows for the idea that children are not unaffected by their challenging circumstances, but rather that they have systems and mechanisms for continuing to thrive despite their particular difficult situation.

A seminal study in the resilience literature is a longitudinal study conducted by Werner and Smith (1992). Werner and Smith (1992) collected data on all 698 babies born in 1955 on the island of Kauai, Hawaii. The researchers followed these babies to

adulthood checking on them at ages 1, 2, 10, 18 and 32 years to investigate how they were developing and progressing through life's various transitions. At birth, approximately one-third of the babies in the study (n = 201) were deemed high-risk because of poverty, perinatal stress, or family dysfunction including parental psychopathology (Werner, 1993). Yet, one third of these high-risk babies (n = 72) were well-adapted and competent by the age of 18. The individuals who successfully navigated their way through to adulthood were labeled *resilient*. While it perhaps struck the researchers as anomalous that children might escape the negative predictions of their future outcomes, Masten (2001) describes it as "ordinary magic." She writes:

> The great surprise of resilience research is the ordinariness of the phenomena. Resilience appears to be a common phenomenon that results in most cases from the operation of basic human adaptational systems. If those systems are protected and in good working order, development is robust even in the face of severe adversity; if these major systems are impaired, antecedent or consequent to adversity, then the risk for developmental problems is much greater, particularly if the environmental hazards are prolonged. (p. 227)

Risk and Resilience

The study of resilience necessarily involves a discussion of risk, whether one conceptualizes resilience as only being possible in the presence of risk or as only being demonstrable in the presence of risk. It was through the study of at-risk groups that the concept of resilience began to gain prominence. However, as the construct of resilience grew in prominence, the way in which resilience was identified became problematized. Masten and Obradovic (2006) write:

> Resilience is quintessentially inferential: to judge the resilience of a system requires criteria for identifying whether the system is doing whatever it is supposed to be doing, and also whether there is or has been a potential threat to the system. Thus, if one identifies a child as resilient, two judgments have been made: this child meets expectations for positive adaptation and there has been a significant threat to the adaptation of the child. (pp. 14-15)

Kaplan (2005) raises concerns regarding whether risk is indeed necessary for a person to be labeled resilient, what level of risk is necessary for one to be resilient, and the method by which the risks are identified. Masten (2001) writes that "individuals are not considered resilient if there has never been a significant threat to their development…. In other words, there must be demonstrable risk" (p. 228). However, other researchers such as Brooks and Goldstein (2001) argue that resilience is a quality that any person can possess, whether or not circumstances precipitate its expression. Brooks and Goldstein (2001) describe a resilient child as "an emotionally healthy child, equipped to successfully confront challenges and bounce back from setbacks" (p. 5).

Operationalizing the Construct of Resilience

As interest in the construct of resilience has grown, so too has a number of conceptual difficulties. Kaplan (2005) writes: "the deceptively simple construct of resilience is in fact rife with hidden complexities" (p. 39). Some of these conceptual difficulties include a lack of clarity in the definition of resilience and the differing risk factors and measures of positive outcome that are experienced by children who are labeled resilient (Luthar, Cicchetti, & Becker 2000).

Resilience has typically been identified based on outcomes relying on the judgments of an external observer who sets pre-determined criteria for the risk and outcomes that characterize resilience. The typical case is illustrated in Table 1. Many studies have focused on comparing students who face some risk factor and do not have positive academic outcomes, represented by Group III, with those students who face the same risk factor yet achieve positive outcomes, represented by Group IV. Members of Group III have typically been referred to as non-resilient, whereas members of Group IV have typically been referred to as resilient—the ones who were able to succeed despite their challenging circumstances. Researchers who conceive of academic resilience in this way are using an *outcome-based approach*, and they have used a variety of measures of risk and academic achievement in order to identify resilient outcomes. For example, risk factors studied from an outcome-based approach have included low socioeconomic background (Borman & Overman, 2004; Waxman & Huang, 1996), belonging to a minority group (Alva, 1991; Morales & Trotman, 2010), or having experienced prior academic failure (Cappella & Weinstein, 2001). Measures of success studied have included high performance on a standardized test (Borman & Overman, 2004; OECD, 2011; Waxman & Huang, 1996), significant positive change in test scores (Cappella & Weinstein, 2001), or matriculation at college (Morales & Trotman, 2010). Academic resilience is then inferred based on the intersection of these two criteria—a pre-specified risk factor and a pre-specified academic achievement measure. See Appendix A for a list of select resilience studies and the ways in which they have operationalized academic resilience.

Two widely used factors in academic achievement research in the United States continue to be socioeconomic status (SES) and ethnic/racial minority status (Sirin, 2005). Sirin (2005) in a meta-analytic study finds that "Of all the factors examined in the meta-analytic literature, family SES at the student level is one of the strongest correlates of academic performance. At the school level, the correlations were even stronger" (p. 438). The relationship between SES and academic achievement is not limited to the United States. Rothstein (2004) writes that "although many countries' students do better on academic tests, on average, than Americans, class backgrounds influence *relative* achievement everywhere" (p. 20). This negative relationship between SES and academic achievement globally has spurred resilience research by the Organization for Economic Cooperation and Development (OECD) based on the Program for International Student Assessment (PISA) (OECD, 2011). Morales and Trotman (2004) write, "the research shows that being poor makes anyone vulnerable, and that being both poor and a member of a racial minority group makes one especially vulnerable when considering academic achievement" (p. 6). Gonzalez and Padilla (1997) write that even those Mexican Americans who do not live in poverty may be at risk due to the difficulties inherent in being a Mexican American and seeking to learn a new culture with its associated norms, which may be quite different from one's own. In addition they may have additional stress related to perceived discrimination and unwelcoming environments. Therefore, the risk to academic achievement might be compounded for these students. They may have trouble speaking and understanding English, or have parents who are not familiar with the United States school system.

While the researchers above have focused on group-based conceptions of risk, some have argued that a focus on distal risks may in fact overstate the risk group. For instance, focusing on the entire group of students with a low socioeconomic background may include some students who really are not at risk, while excluding some students who face very present risks to their academic success. Cappella and Weinstein (2001) and Catterall (1998) emphasize the importance of focusing on proximal risk. They focus on prior academic failure, which they argue would be more a more direct risk factor than belonging to a low socioeconomic group.

With such different conceptualizations of resilience, one might be led to believe that the research findings would be quite disparate. Yet, despite the varied ways in which researchers have conceptualized and operationalized resilience, many of the findings across studies have pointed to three main factors that lead to resilient outcomes: factors associated with the individual, factors associated with the family, and factors associated with external support (Condly, 2006). Masten, Herbers, Cutuli, & Lafavor (2008) refer to the factors that differentiate those who face adversity and emerge competent from those who face similarly negative circumstances but do not emerge competent as the "short list". This "short list" includes individual factors such as intelligence, problem-solving skills, self-regulation skills and persistence, family or environmental factors such as positive relationships with caring adults, positive friends, effective teachers and schools, and also a sense that life is worthwhile (p. 79).

These outcome-based approaches to identifying resilience has led many researchers to describe resilience as both subjective and inferential (Bartelt, 1994; Gordon & Song, 1994; Masten & Obradovic, 2006; McCord, 1994). Missing from

studies on resilience is an understanding of how these students perceive themselves (Garbarino, 2005). It is not simply the presence of a risk factor that is important, rather it is how this risk factor is experienced and perceived by the child. For example, there are numerous anecdotes of children who grew up in poverty, yet never knew that they were poor until they reached adulthood. This is because their parents effectively shielded them from the effects of the family's poverty. Therefore, although this child came from a low socioeconomic background, the effects of this risk factor on his or her life trajectory may not have been as detrimental as for a child from a similar background who was very aware of the extent of his or her family's poverty. Bartelt (1994) expands on this point regarding the subjectivity of resilience writing, "resilience is clearly a term that is externally applied...by observers of a series of actions and outcomes. But central to the concept is a set of subjectively defined goals, aspirations, and barriers" (p. 102). Bartelt (1994) goes on to write:

> The position of poor and minority children in inner-city schools…is still a world apart from that presumed by an academically oriented achievement model. To begin with resilience, as defined by success under that set of values, is to miss the important dynamics of the students' subjective world view. (pp. 105-106)

While this argument could then be understood to mean that even a focus on academic resilience is unwarranted because an external observer is the one who decides that academic achievement is important, it cannot be denied that success in school and success in life are inextricably linked. As Elias, Parker and Rosenblatt (2005) write:

> Although academic completion and achievement are "positive" outcomes only because they are valued by the dominant culture, they are nonetheless agreed-

> upon by the educational system and its participants. Arguably, families who participate in the public education system enter into an unwritten social contract with their schools that is fulfilled only through the exchange of a set level of skill accumulation and degree attainment for a certain amount of schooling. (p. 319)

In other words, academic achievement is an "age-salient developmental task" (Masten & Obradovic, 2006, p. 15) that has great consequences for one's future life outcome. Garbarino and Abramowitz (1992) concur writing "in a world such as our own, where academic success is important, to be an alien to the academic culture is to be at developmental risk" (p. 46).

A distinction is drawn throughout this study between outcome-based resilience and self-perceptions of resilience measured throughout this dissertation using the academic resilience in mathematics (ARM) scale. A focus on self-perceptions is important because "what counts as resilience often depends on the perspective" (McCord, 1994, p. 110). The ARM scale builds on work by Martin and Marsh (2008, 2009) who constructed a 6-item scale to measure student self-perceptions of academic resilience scale. In later studies, this scale was reduced to a 4-item scale and the construct renamed academic buoyancy (Martin & Marsh, 2008; Martin, Colmar, Davey, & Marsh, 2010). A distinction was drawn between maintaining competence when facing low-level threats versus severe threats to academic functioning. Thus, they bifurcated the construct of academic resilience, retaining academic resilience as the construct for more acute or chronic adversity, and academic buoyancy for referring to what they term an "everyday resilience" (Martin & Marsh, 2008, p. 54). They write that while academic buoyancy may lead to academic resilience it does not have to, noting that "it is probable that

academic buoyancy is a necessary but not sufficient condition for academic resilience" (Martin & Marsh, 2008, p. 77). The academic resilience in mathematics (ARM) scale used in this study includes adaptations of the four items included in Martin & Marsh's (2008) academic buoyancy scale. The ARM scale also includes items measuring student perceived support and student future goals as these are seen as salient based on a review of the resilience literature (Constantine & Benard, 2001; Gordon & Song, 1994). The congruence between these two approaches—outcome-based and self-perceptions—to identifying resilience will be explored in Chapter Three.

Implicit Theories of Intelligence (Mindsets)

Research suggests that a person's beliefs have implications for how that person handles difficulty (Blackwell, Trzesniewski, & Dweck, 2007). One belief that has been shown to be important for understanding academic resilience is the implicit theory of intelligence that a person holds (Yeager & Dweck, 2012). As part of this study, I examine the importance of students' implicit theories of intelligence on other motivational constructs, their academic resilience and academic achievement. Such beliefs are important as they undergird the actions that a student undertakes.

Implicit theories of intelligence refer to the views about intelligence that individuals hold. There are two main views: 1) an incremental theory of intelligence and 2) an entity theory of intelligence. Those who hold an incremental theory of intelligence believe that intelligence can change over time, whereas those who hold an entity theory of intelligence believe that intelligence is immutable (Dweck & Leggett, 1988). Yeager and Dweck (2012) found that the theory of intelligence or the mindset that an individual holds is related to their academic resilience. They find "students' mindsets can be

changed and that doing so can promote resilience" (p. 303). Additionally, researchers have found that for students of equal ability, the views a student holds about intelligence influence how that student handles academic challenge (Blackwell, Trzesniewski, & Dweck, 2007).

Self-regulated learning

Schunk, Pintrich, and Meece (2002) define self-regulation or self-regulated learning as "the process whereby students personally activate and sustain behaviors, cognitions, and affects that are systematically oriented toward the attainment of goals" (p. 380). In recent years self-regulated learning has emerged as a meaningful construct for "explaining unexpected outcomes at both ends of the achievement spectrum: personal accomplishment in the face of steep odds, as well as underachievement and low self-esteem" (Zimmerman, 1994, p. 5) and has been found to be related to students' academic resilience (Martin & Marsh, 2006).

Linnenbrink (2005) describes cognitive engagement as being made up of two factors: quantity and quality of self-regulation. The quality of self-regulation items on her cognitive engagement scale ask students about how often they used particular strategies when doing mathematics assignments. The quantity of self-regulation items asked them about their persistence behaviors when working on mathematics. These are similar to two of the three components that Pintrich and DeGroot (1990) describe as typically being included in definitions of self-regulated learning: strategy use, and persistence behaviors.

Chapter Three: Exploring the Relationship between an Outcome-Based Definition of Academic Resilience and Self-Perceptions of Academic Resilience

The study of resilience can be traced back to the work of researchers in the field of developmental psychopathology (Luthar, Cicchetti, & Becker, 2000). Researchers in this field studied children who were identified as facing risk and sought to understand how such risk led to disorder. Yet, what they found was that simply having a risk factor did not necessarily lead to disorder; in fact, there was a large amount of variability in outcomes (Masten & Tellegen, 2012). In 1955, Werner and Smith began a longitudinal study on the island of Kauai, Hawaii. They accounted for all the babies born on the island that year paying attention to the types of risks such as prenatal stress and poverty that the child faced at birth. They identified one third of the babies born that year as being at risk due to prenatal difficulties, poverty, parental psychopathology or discord. They followed up on these babies at various time points (Werner, 1993; Werner, Bierman, & French, 1971; Werner & Smith, 1992). When they followed up with these children as 18-year old adults, they found that one-third of the babies that had been identified as high-risk at birth had adapted well into adulthood. These competent adults who had been born into challenging circumstances were deemed the resilient ones (Werner & Smith, 1992).

Academic or educational resilience is often defined as "the heightened likelihood of success in school and in other life accomplishments, despite environmental adversities, brought about by early traits, conditions, and experiences" (Wang, Haertel, & Walberg, 1994, p. 46). The focus here is squarely on success in school and in educational pursuits.

In this chapter, I distinguish between two approaches that have been taken to studying academic resilience: an outcome-based approach and an approach based on self-perceptions. The outcome-based approach is one in which academic resilience is determined based on an intersection of risk and academic success (see Table 1). The student self-perceptions approach asks students how well they think they are able to handle challenges that might impinge on their academic success.

The purpose of this chapter is to investigate the congruence between these two approaches to measuring academic resilience. Studying the same construct from different approaches and using different methods help to clarify our understanding of the construct. Specifically this study seeks to address the following research question:

1. What is the relationship between a student's academic resilience as defined from an outcome-based perspective and as defined by the student's self-perceptions?

Theoretical Overview

This study of academic resilience is grounded in social cognitive theory (Bandura, 1989). In social cognitive theory, Bandura (1989) posits a reciprocal relationship between person, environment and behavior. With this theoretical framework in mind, we argue that academic resilience includes not just beliefs about a student's personal abilities, but also beliefs a student holds about his or her environment.

Outcome-based definition of Academic Resilience

As used in this study, an outcome-based definition of academic resilience refers to the way in which academic resilience is determined based on the intersection of two factors: the presence of one or more risk factors and the achievement of some measure of academic success. Table 1 shows the typical classification that is used to identify

resilience in this outcome-based approach. There are at least four groups that can be created using this classification. Group I includes students who do not have the risk factor, yet are academically unsuccessful. Group II includes students who also do not have the risk factor and are academically successful. Group III includes students who have the identified risk factor and are academically unsuccessful. In some studies these students have been referred to as non-resilient and have been used as the comparison group for the resilient students. These are the students in Group IV who despite having the identified risk factor are academically successful. Below, I highlight three studies that have used this outcome-based definition of academic resilience and the findings from these studies. The first study is a quantitative study. The second is a qualitative study. The third is a quantitative study, but differs from the first two in that it is based on a large scale international dataset.

Waxman and Huang (1996) defined the risk group as black and Hispanic 6th, 7th, and 8th grade students who attended an inner-city middle school. The educationally resilient group were those students from the risk group who scored at or above the 90th percentile on standardized mathematics achievement tests over a 2-year period. The comparison group, the non-resilient students, were those students from the risk group who scored at or below the 10th percentile on standardized mathematics achievement tests over a 2-year period. The researchers found that the resilient students were much more motivated and much more satisfied with their mathematics classes than the non-resilient students. They found no significant difference on variables such as parental involvement, homework, affiliation, and teacher support.

Morales and Trotman (2004, 2010) took a slightly different approach. In their qualitative study they interviewed students who by their definition were resilient or had "beaten the odds." They define academic resilience as "the process and outcome of students who despite coming from statistically "at-risk" backgrounds, *do* succeed academically" (p. 1). Their study included only resilient students. In order for a student to be labeled resilient, the student must have met two criteria: 1) had parents with limited educational backgrounds who worked in low or semi-skilled jobs and self-identified as an ethnic minority, and 2) at the time of the interviews had completed a minimum of 30 college credits and had a minimum GPA of 3.0. They found that these resilient students actively sought help, and had a strong locus of control.

The researchers at the OECD describe resilient students as those who "come from disadvantaged backgrounds yet exhibit high levels of school success" (OECD, 2011, p. 22). Based on the student performance on the 2006 PISA science assessments, the researchers at the OECD labeled those students who were in the bottom 33% of the PISA index of economic, social and cultural status (ESCS), their measure of socioeconomic status, and scored in the top 33% of all students on the PISA science assessment as resilient. Students who shared the same socioeconomic background, but scored in the bottom 33% on the PISA science assessment were labeled as non-resilient. The researchers compared the non-resilient and the resilient group and found differences in student motivation, interest in science, student engagement, confidence, and their perspectives toward science careers (OECD, 2011). Outcome-based studies such as the ones above have provided many useful findings with regards to academic resilience. By comparing students from similar backgrounds who have different outcomes, some of

these studies have highlighted characteristics that help students facing adverse conditions or challenges maintain academic success. For example, Benard (1993) found that the following four personal characteristics were typical of resilient children: social competence, problem-solving skills, autonomy, and sense of purpose. Masten, Herbers, Cutuli, & Lafavor (2008) describe what they call the "short list" referring to commonly observed predictors of resilience: positive relationships with caring adults, effective parenting, intelligence, problem-solving skills, perceived efficacy, control achievement motivation, persistence, self-regulation skills, effective stress management, positive friends, romantic partners, faith, hope, spirituality, belief that life has meaning, effective teachers, and schools (p. 79).

Despite these findings, there have been criticisms of this outcome-based approach to measuring and identifying resilience. In his critique, Kaplan (2005) writes that "the deceptively simple construct of resilience is in fact rife with hidden complexities" (p. 39). He asks whether one needs to have experienced an adverse life circumstance in order to be called resilient and whether resilience refers to a pre-existing ability to overcome adversity. He also finds the inferential nature of the outcome-based approach to identifying resilience problematic (Kaplan, 2005). An additional concern is that many studies identify resilient students on the basis of one achievement test, which may not be fully representative of students' academic achievement (Waxman, Gray, & Padron, 2003). I argue that in an outcome-based approach, individual students and their perceptions of challenges and resources are no longer the focus. Rather, the identification of resilient outcomes is external to the student. It is the researcher who chooses the specific criteria by which resilient students are identified. Such a classification fails to account for the

student perspective of their situations, resources, and personal strengths. What the researcher perceives as a risk may not in fact be a risk to the child, and what the researcher perceives as a measure of good academic outcome may not be salient in the worldview of the child. Morales and Trotman (2004) write that "for most of these [resilient] students it was usually only in retrospect that they were fully aware of the disadvantages they faced" (p. 143). It is plausible that the risk factors used by the researcher may not have affected the student's ability to maintain academic competence, whereas there may be other unidentified risks that are much more salient in the life of this particular student to his attaining academic success. Therefore, the perceptions that students hold are important to consider in the study of resilience. Yeager and Dweck (2012) write "resilience is not exclusively a quality of a person or of a context, but rather it can also be the consequence of a person's interpretations of the adversities they are facing" (p. 312).

Additionally, the outcome-based approach can be problematic because of its post-hoc nature. Using the classification system as laid out in Table 1, it is not possible to identify resilient or non-resilient students until after a meaningful outcome has occurred. As a result, identifying such students is no longer particularly useful from an intervention perspective as the outcome has already occurred, and for those who did not achieve the desired outcome there is no longer an opportunity to intervene to potentially alter that child's life trajectory. Bartelt (1994) writes:

> Resilience is clearly a term that is externally applied…by observers of a series of actions and outcomes. But central to the concept is a set of subjectively defined goals, aspirations and barriers. (p. 102)

Therefore it is important to pay attention to how students perceive their own circumstances, their ability to be successful, and their goals for the future. Viewed in this way, the findings from resilience research have implications for all children, not only those who are pre-identified as at-risk based on some pre-determined risk factor (Goldstein & Brooks, 2005).

Student Self-Perceptions of Academic Resilience

A number of instruments have been created to measure resilience more generally, and to measure academic resilience more specifically. I will give two examples of such scales that have been used to measure the more general construct of resilience, and one example that has been used to measure academic resilience, and upon which the scale used to measure academic resilience in this study builds.

The Brief Resilience Scale (Smith et al., 2008) focuses on the relationship between resilience and health outcomes. They write that "the belief that one can bounce back from stress may be critical for actually being able to do so" (p. 167).

The CD-RISC scale (Connor & Davidson, 2003) includes 25 items. The authors write "resilience embodies the personal qualities that enable one to thrive in the face of adversity" (p. 76). A factor analysis of the scale reveals five factors: personal competence, the strengthening effects of stress, secure relationships, control, and spiritual influence. They find that the scale exhibits good psychometric properties, but raise concerns about the domain-specificity of the construct, and the directionality of the causation of resilience—does resilience cause a particular response or is resilience the outcome?

The scale used as the measure of student self-perceptions of academic resilience in this study builds on research by Martin & Marsh (2006, 2008, 2009). Martin and Marsh (2006) created and tested a 6-item academic resilience scale. In later research, they bifurcated the construct into academic buoyancy and academic resilience, arguing for a distinction between the two and referring to academic buoyancy as an "everyday resilience" (Martin & Marsh, 2008, p. 54). Academic buoyancy, they argue is distinct from academic resilience, which they describe as the ability to deal with more chronic or severe adversity. The academic buoyancy scale retained four of the six items from the original academic resilience scale.

While self-perception measures of resilience add to our understanding of how the individual understands and interprets the challenges he or she faces it is not clear that the outcome-based approach and the self-perspective approach would yield identical findings. With the risk measure being chosen by the researcher and not based on the individual's perception of risk, individuals who are being identified as at-risk may not think they are indeed at risk, whereas others who are really struggling may not be identified as at-risk based on the researcher-chosen measure.

Methods

Participants

The participants in this study were 528 7^{th} (n = 254) and 8^{th} grade (n = 273) students with one student who did not indicate grade level. These students attended a low-income urban school in the southeastern United States, and they completed the academic resilience in mathematics (ARM) scale. There were 237 males, 279 females, and 12 students who did not identify their gender. The majority of the students in the

sample identified as Black/African-American (44%) or Hispanic/Latino (25%) with 14% identifying as White and the remainder as Asian, Other or did not report. 66.1% of students were eligible for free or reduced-price lunch, which was used as a proxy for low socioeconomic status. There were 23 students (4%) who did not answer one or more items on the ARM scale.

On the statewide-standardized mathematics assessments, 89% of students met the standards for 7th grade (including 35% who exceeded the standards), and 81% of students met the standards for 8th grade (including 17% who exceeded the standards).

Measures

This study was part of a larger program of research that examined a number of motivational variables and their relationship to student academic achievement in this middle school (7th and 8th grade) population. Consent was received from the parents or guardians and assent from the students who participated in the study. Students completed the survey during the first period of the day which is designated as "home room." Students completed the entire survey over a two-day period and returned the completed surveys to their home room teacher who then returned them to the researchers. Demographic information was collected as well as student responses to a number of psychological assessments.

Student Self-Perceptions of Academic Resilience. Student self-perceptions of academic resilience were measured by the academic resilience in mathematics (ARM) scale (Ricketts, Engelhard, & Chang, 2015), which measured student perceptions of their ability to do well in mathematics despite challenges they might face. The scale included 9 items. An analysis of the scale using Rasch measurement theory (Engelhard, 2013)

found that the scale exhibited good psychometric properties. The reliability of person separation was good (*Rel* = .79), and the scale exhibited good model-data fit.

Outcome-based Academic Resilience. A variable was created to capture outcome-based academic resilience. This variable was created based on the intersection of researcher-identified risk and academic achievement based on the categorization shown in Table 1. Student socioeconomic status (SES) was used as the measure of risk. Student SES was measured by student eligibility for free or reduced-price lunch. Students who were eligible for free or reduced-price lunch were categorized as low SES and students who were not eligible for free or reduced-price lunch were categorized as high SES. Student academic achievement was determined based on student performance on a criterion-referenced statewide standardized mathematics assessment that was taken in the same semester that students completed the surveys. Based on their results from this assessment, students are categorized into one of three performance levels: fails to meet the standards, meets the standards, or exceeds the standards. For the purposes of this study, the performance variable was dichotomized with students who failed to meet the standards placed in one group, and students who either met or exceeded the standards placed in another group.

The intersections of the risk variable and the academic achievement variable were used to create four groups of students on this outcome-based academic resilience variable (see Table 2). Students who were not eligible for free or reduced-price lunch (high SES) and failed to meet the assessment standards were labeled Group I (n = 9). Students who were not eligible for free or reduced-price lunch (high SES) and met or exceeded the assessment standards were labeled Group II (n = 170). Students who were eligible for

free or reduced-price lunch (low SES) and failed to meet the assessment standards were labeled Group III (n = 43). Students who were eligible for free or reduced-price lunch (low SES) and met or exceeded the assessment standards were labeled Group IV (n = 306). The students in Group IV represent the group of students who have traditionally been labeled resilient as they are in the risk category and have achieved academic success as measured by student performance on the statewide standardized mathematics assessment. The students in Group III represent the group of students who have typically been labeled "non-resilient" as they are the students who are in the same risk category as the resilient students, but have not achieved academic success.

Procedure

This study uses Rasch measurement theory (Engelhard, 2013) as the measurement framework for investigating the congruence between outcome-based resilience operationalized by the four groups described earlier and self-perceptions of resilience operationalized through student ratings on the ARM scale. Specifically, this study uses the Many Facet (MF) model (Linacre, 1989), which is a member of the family of Rasch models (Engelhard, 2013). The MF model allows for the inclusion of additional facets into the model. In this study, the additional facet that is included is the outcome-based resilience variable. Using the MF model allows for the estimates of this facet to be created on the same logit scale as item difficulty and person ability. Additionally, the ability to obtain a variable map, one of the benefits of the family of Rasch models, is maintained with the MF model. The variable map places items, respondents and additional facets on the same logit scale allowing for a visualization of the locations of the items, persons, and facets simultaneously (Engelhard, 2013). A partial-credit

parameterization was applied to the scale component, as it cannot be assumed that respondents were using the scale in the same way (Masters, 1982). The Facets program (Linacre, 2013) was used to perform the analyses. The mathematical equation used for the analysis can be written as:

$$\ln \frac{P_{nijk}}{P_{nijk-1}} = \theta_n - \delta_i - \Delta_j - \tau_{ik} \qquad [1]$$

where

P_{nijk} = the probability of student *n* responding in category *k* on item *i*,

$P_{nijk\text{-}1}$ = the probability of student *n* responding in category *k-1* on item *i*,

θ_n = the underlying level of academic resilience for student *n*,

δ_i = the location of item *i*,

Δ_j = explanatory variable j, and

τ_{ik} = the difficulty of responding in category *k* relative to category *k-1* for item *i*.

Results

The Rasch summary statistics from the Facets analyses can be found in Table 3. The measures are the locations of the facets on the latent variable scale. The mean of the student measures is .77 logits (SD = 1.04). Infit and Outfit are mean square error statistics that represent model-data fit. For these data, the measures for Infit and Outfit statistics are all close to the expected value of 1.00 based on the model, indicating good model-data fit (Engelhard, 2013). The reliability of separation and χ^2 indicate the spread of the elements within each facet. Reliability of person separation is good ($Rel_{\text{Student}} = .78$, $p < .01$). Reliability of separation for items was .99 ($p < .01$).

Figure 2 shows the variable map for students, items, and the outcome-based academic resilience facet based on the MF model. The variable map shows a good spread of both students and items. The locations of the groups of students along the outcome-based variable of academic resilience can also be seen on the variable map. There was a statistically significant difference in self-perceptions of academic resilience based on the outcome-based groupings of academic resilience ($\chi^2 = 14.3$, $df = 3$, $p < .01$), with students who were in Group II, that is the students who were high SES and met the standards on the standardized assessment reporting the highest levels of self-perceptions of resilience (.12 logits, SE = .02). The next group was Group III (.08 logits, SE = .05). These students are the ones with low socioeconomic backgrounds and who failed to meet the standards. The next group was Group IV (.05 logits, SE = .02). This group of students would be the ones termed resilient from an outcome-based perspective as they come from a low socioeconomic background yet have achieved a measure of academic success, here measured by meeting or exceeding the standards on a statewide mathematics exam. The final group was Group I (-.24, SE = .10). These are students who come from a high socioeconomic background but who are failing academically as measured by performance on a standardized mathematics exam. The reliability of separation for these groups was .83, which is fairly high and indicates the strength of the scale in distinguishing between the self-perceptions of academic resilience of students in the different outcome-based groups.

The results of t-tests between each pair of groups can be seen in Table 4. This table shows that there are statistically significant differences between self-perceptions of academic resilience for students in Group I and those for students in each of the other

groups with the students in Group I scoring significantly below each of the other groups on the measure of self-perception of academic resilience. The only other statistically significant difference is between Group II and Group IV. That is students from the high-income high-achieving group (Group II) rated themselves significantly higher on the measure of self-perception of academic resilience than students in the low-income high-achieving group (Group IV). Perhaps most interestingly, there was no statistically significant difference between the ratings on the self-perception measure of academic resilience between the students in Groups III and IV, even though these are the two groups of students that are most often compared in outcome-based resilient studies.

The bias and interaction plot in Figure 3 shows the functioning of each of the items on the scale by the four outcome-based resilience groups. Group III students have statistically significant different functioning on Item 3 (“I think I’m good at dealing with pressures in math”) and Item 6 (“I believe that math will be useful to me I the future”).

Discussion

The Academic Resilience in Mathematics (ARM) scale used in this study was designed to measure student perceptions of their ability to handle academic challenges, including perceptions of personal strengths, and also their perceptions of the environment. The purpose of this study was to investigate the congruence between the outcome-based definition of resilience that has often been used in studies on resilience and student self-perceptions of academic resilience. The two groups that have typically been compared have been students from a low socioeconomic background who either have low academic achievement (Group III—*non-resilient*) or have high academic achievement (Group IV—*resilient*). In this study, I found that Group III students

reported higher levels of academic resilience than Group IV students. However, the t-value for the difference between these two groups was 0.56, which is not statistically significant. Additionally, Group III only included 43 students compared to Group IV, which included 306 students.

One perhaps surprising finding from this research is the location of Group I students. The self-perception of academic resilience for these students—those from high SES backgrounds, but who were not achieving academically—was statistically significantly lower than the other three groups. In interpreting this finding, it should be kept in mind that there were only 9 students in this group. With such a small group the parameter estimates are unstable (Bond & Fox, 2007). However, this finding does provide an interesting area for future research. It may be that the support that such students need to attain academic success are qualitatively different from the support needs of students who have typically been identified as resilient, i.e. the Group IV students.

There are a number of limitations to the research summarized in this chapter. The way in which the outcome-based academic resilience variable was created could change the findings of the study as these decisions were based on my chosen criteria. In creating the outcome-based variable, two relatively rough indicators were combined: (1) a measure of student socioeconomic status based solely on student eligibility for low and reduced-price lunch, and (2) student achievement based on performance on a statewide criterion-referenced standardized assessment. Therefore, the errors in classification of students based on each of these two indicators may affect inferences drawn about outcome-based academic resilience. There were not many students (15%) who failed to

meet the minimum performance standards based on the statewide standardized mathematics assessment. Therefore, one may argue that this sample is not a particularly low-performing sample. However, the purpose of this study was to investigate whether the way in which students perceived themselves was congruent with the ways in which they would have been categorized based on an outcome-based measure. This study has found that these two ways of operationalizing academic resilience are in fact not congruent and can lead to different findings and a discussion of different groups of students. Therefore, I propose using both approaches as complementary.

In the next chapter, I explore the role that student perceptions of academic resilience play in predicting academic success for students from different risk backgrounds. These risk groups are once again researcher-chosen. However, this exploration will help to illuminate whether student perspectives of academic resilience play a role in explaining academic success for different groups of students categorized based on observable criteria. As it is not often practicable to get student perception information, often those involved in the lives of children will have to rely on such observable information, and so understanding the role of self-perceptions of academic resilience in this context is important.

Chapter Four: Academic Resilience and its Ability to Differentiate Student Outcomes

Interest in resilience research has been growing over the past few decades (Luthar, Cicchetti & Becker, 2000). It may be the hopeful nature of resilience—"that there are qualities in individuals or their environments that enable them to face difficulties and overcome them" (p. 110)—that has spurred this interest. Rather than focusing on negative outcomes, one can instead look to those who do succeed and see that is success is indeed possible. Person qualities that have been shown in prior research to be related to resilience include student motivation, self-confidence (OECD, 2011); social competence, problem-solving, autonomy, sense of purpose (Benard, 1993); engagement, positive outlook towards school, and high self-esteem (Borman & Overman, 2004).

The focus of this study is on academic resilience, defined as "the heightened likelihood of success in school and in other life accomplishments, despite environmental adversities, brought about by early traits, conditions, and experiences" (Wang, Haertel and Walberg, 1994, p. 46). Resilience has typically been determined based on an intersection of risk and positive outcome. In other words, in order to be identified as academically resilient a student had to be in a pre-designated risk group and also have met some pre-determined cut-off for academic achievement. This study seeks to expand the conceptualization of academic resilience to include a focus on student perceptions. It is not necessarily apparent that these two ways of measuring academic resilience would be congruent. In fact, the results of Chapter Three show us that they are not with the ordering of the outcome-based resilience groups not being the way that would have been

hypothesized in an outcome-based approach. In other words, students who would have been identified as resilient in an outcome-based approach may not necessarily perceive themselves as resilient. This study builds on this finding and explores how student perceptions of academic resilience influence academic outcomes for all students, for students who are facing an externally-defined measure of risk and for those students who are not.

Theoretical Framework

Academic resilience has typically been operationalized as an outcome-based measure. In this typical framework, two pieces of information are needed to determine if a student has been academically resilient—1) the presence of risk and 2) the achievement of a successful academic outcome (see Table 1). This way of identifying resilience has been called "quintessentially inferential" (Masten & Obradovic, 2006, p. 14). Risk factors used have generally included one or a combination of the following: low socioeconomic background, minority group status and prior academic failure. Students with these characteristics who also achieved academic success were labeled academically or educationally resilient. The academic success criteria used have included high standardized test scores, significant growth in test scores, and college matriculation (Alva, 1991; Borman & Overman, 2004; Cappella & Weinstein, 2001; Morales & Trotman, 2010; Waxman & Huang, 1996). See Appendix A for a summary of key academic resilience studies, the measures that were used to identify academic resilience in each of the studies, and key findings.

In this study, I argue for the use of a complementary approach to measuring academic resilience. This approach is based on student self-perceptions. Bandura (1989) writes:

> Threat is not a fixed property of situational events, nor does appraisal of the likelihood of aversive happenings rely solely on reading external signs of danger or safety. Rather, threat is a relational property concerning the match between perceived coping capabilities and potentially aversive aspects of the environment. (p. 1177)

Therefore, it is not just the presence of a risk factor, it is also how that risk factor is perceived by the student that it is important. Thought about in this way, any student, regardless of risk, can be academically resilient. However, it may be that academic resilience is more important for students who are already facing challenges to their academic success.

This study focuses on academic resilience in mathematics in a middle school population. This time period is particularly important to future success in mathematics as research has shown that it is during this time period that student enjoyment of mathematics being to decline. Additionally, it is around this time that student motivational attitudes become less amenable to change. These attitudes then influence student choices regarding mathematics coursework in both high school and college (Middleton & Spanias, 1999). Therefore, understanding student ability to handle challenges to their academic success in the domain of mathematics at this transitional juncture is particularly crucial.

Purpose

This chapter explores whether students self-perceptions of academic resilience mediate the relationship between externally-defined risk and externally-defined academic achievement. Specifically, this research is guided by the following two research questions:

1. Do student self-perceptions of academic resilience mediate the relationship between risk and academic achievement for all students?
2. Do student self-perceptions of academic resilience function differently for students at various levels of risk?

Method

Participants

The data used in this chapter were collected as part of a larger study investigating the relationships between a number of motivational variables and academic achievement in the context of a middle school (grades 7 and 8) mathematics classroom. This study includes 606 7^{th} (n = 289) and 8^{th} (n = 315) grade students. There were two students who did not report grade level information. 87 students (15%) did not report their gender. Of those who did, 46% were males and 54% were females. All students attended the same middle school located in the southeastern United States. The school is designated a Title I school, which means that a preponderant portion of its student population qualify for free or reduced-price lunch. Of the students in this study, 67% were eligible for free or reduced-price lunch. Seventeen percent of the sample did not identify their racial background. Of those who did, 45% identified as Black/African-American, 27%

identified as Hispanic/Latino, 15% as White, and 13% as Other, Asian, or Native-American.

Measures

Risk Factors. Two risk factors were used as part of this study: 1) student socioeconomic status and 2) student prior academic failure. Student socioeconomic status was measured by student eligibility for free or reduced-price lunch. Information on student eligibility for free or reduced-price lunch was obtained directly from the school. Students who were eligible for free or reduced-price lunch were categorized as low SES. Students who were not eligible for free or reduced-price lunch were categorized as high SES. Eligibility for free or reduced-price lunch was coded as "1" (n = 403) and non-eligibility for free or reduced-price lunch was coded as "0" (n = 199). Four students were missing data for this variable. Student prior academic failure was determined based on whether students failed to meet the standards on the statewide standardized mathematics examination given in the previous year. Performance on this assessment is divided into three levels: fails to meet the standards, meets the standards, and exceeds the standards. For the purposes of this study, the performance levels were dichotomized. Scores that represented a failure to meet the standards were coded as "1" (n = 49) and scores that met or exceeded the standards were coded as "0" (n = 557).

High Risk. A high-risk variable was created to capture students who fell into both the socioeconomic status risk group and the prior academic failure risk group. Students who had both risk factors of low SES and prior academic failure were categorized as high risk (n = 41).

Low Risk. A low-risk variable was created to capture students who fell into neither of the risk groups. Students who did not have either risk factor, that is, they were not eligible for free or reduced-price lunch and they did not fail to meet the performance standards on the prior year standardized exam were categorized as low risk (n = 191).

Academic Resilience. The measure of student self-perceptions of academic resilience was measured by student responses to the ARM scale (Ricketts, Engelhard, & Chang, 2015). The scale included 9 items and had high reliability ($\alpha = 0.83$). The mean scores on the ARM scale were used as the measure of student self-perceptions of academic resilience. If a student failed to respond to an item on the scale their mean ARM score was calculated using the mean of the items to which they responded.

Mathematics Pre-Test. This was measured based on student performance on a criterion-referenced statewide standardized mathematics assessment taken in the spring of the year prior to data collection. Scores ranged from 760 to 950 with a mean of 831.91 (SD = 28.76).

Mathematics Post-Test. This was measured based on student performance on a criterion-referenced statewide standardized mathematics assessment taken in the same semester as data collection. Scores ranged from 755 to 990 with a mean of 832.13 (SD = 33.40).

Procedure

Students completed the survey over a two-day period during their "home room" period. Completed surveys were returned to the teacher who was responsible for this period. The teachers then returned the surveys to the research team. Consent was

received from the parents of all students who participated in the survey. Assent was received from all the students.

Three separate hierarchical regression models were estimated using the nestreg command in Stata: Release 13 (StataCorp, 2013). A number of dummy variables were created for inclusion in the models. A dummy variable was created to represent student eligibility for free or reduced-price lunch. A code of 1 was used if the student had this risk measure—that is, if a student was eligible for free or reduced-price lunch—and a code of 0 was used if a student was not eligible for free or reduced-price lunch. A dummy variable was also created to represent whether a student had low prior academic performance. A code of 1 was used if the student had this risk measure—that is, if a student had low academic performance in the prior academic year. A code of 0 was used if the student did not have low academic performance in the prior year. Two additional dummy variables were created in order to categorize those students who were "high-risk" and those students who were "low-risk." A dummy variable was created to label the high-risk students. Students who were both eligible for free or reduced-price lunch and had prior academic failure were coded as 1. Students who did not meet one or both of these criteria were coded 0. A final dummy variable was created to label the low-risk students. Students who were neither eligible for free or reduced-price lunch nor had prior academic failure were coded 1. Students who had either one or both of these risk factors were coded 0.

The dependent variable in each of the models was student post-test scores. However, the samples used for each of the three models differed. The first model included all 606 students. The second model included only the 191 low-risk students.

The third model included only the 41 high-risk students. Additionally, the first model estimated included the following three explanatory variables, which were added to the model in the order listed: 1) eligibility for free or reduced-price lunch, 2) low prior academic achievement, and 3) academic resilience. The variables were added sequentially to test the significance of adding each additional variable to the model and to determine the additional variation in post-test scores explained by that variable. For the second and third models, the only explanatory variable included was academic resilience.

Results

Relationships between Risk Factors, Academic Resilience and Student Performance

Table 5 shows the correlations of the variables included in the hierarchical multiple regression analyses. While there is not a statistically significant relationship between academic resilience and the risk factors, there is a statistically significant relationship between academic resilience and both the pre-test (r =.08) and the post-test (r = .22). The correlation is stronger between academic resilience and the post-test, which was taken in the same semester that students completed the resilience scale.

Table 6 shows the results of the hierarchical multiple regression analyses, and lists the standardized coefficients of the predictors in the model. The first model explores how much academic resilience explains the variation in post-test scores for all students in the sample after controlling for student eligibility for free or reduced-price lunch and low pre-test scores. Eligibility for free or reduced-price lunch explained about 12% of the variation in post-test scores. Having low pre-test scores accounted for an additional 5% of the variation in post-test scores (change in R^2 = .05, p < .001). Finally, including academic resilience accounted for an additional 4% of variation in post-test scores

(change in $R^2 = .04$, $p < .001$). The model is statistically significant with eligibility for free or reduced-price lunch ($\beta = -.32$, $p < .001$), low prior academic achievement ($\beta = -.22$, $p < .001$), and academic resilience ($\beta = .20$, $p < .001$) together explaining about 22% of the variation in post-test scores. The results of the second model showed that academic resilience explained about 2% of the variation in post-test scores among the low-risk sample. However, this model was not statistically significant. Results from the third model showed that academic resilience explained a statistically significant 20% ($p < .01$) of variation in post-test scores among the high-risk sample ($\beta = .45$, $p < .001$).

Discussion

The correlations between academic resilience and the risk factors of eligibility for free or reduced-price lunch and low prior academic achievement were not statistically significant (Table 5). This suggests that student self-perceptions of academic resilience are not dependent on their observable risk status. This supports the findings of the previous chapter regarding the lack of congruence between academic resilience measured based on outcomes and measured based on student self-perceptions. Academic resilience was positively correlated with pre-test scores ($r = .08$) and even more strongly correlated with post-test scores ($r = .22$). The weaker correlation between pre-test scores and academic resilience suggests that academic resilience is not strongly related to prior academic performance. As pre-tests occurred before the measurement of academic resilience takes place, this could be interpreted as pre-tests having only a weak influence on future student perceptions of academic resilience. However, the stronger relationship between academic resilience and student performance on the post-test suggests that

academic resilience may in fact be influencing student academic outcomes. This is explored in more detail in the next chapter.

The hierarchical regression analyses (Table 6) showed that when academic resilience was added to the hierarchical regression model for all students it explained a significant though small portion of the variance of post-test scores (change in R^2=.04, $p <$ .001). Thus, academic resilience does seem to have a benefit to all students, although the effect size is small. It is upon dividing the sample into a high-risk and a low-risk group that it is possible to see the importance of academic resilience to student academic outcomes. For students in the low-risk group, academic resilience was not a statistically significant predictor of their post-test scores. However, for the high-risk group, academic resilience was a statistically significant predictor of post-test scores and explained 20% of the variation in post-test scores. This suggests that student perceptions of academic resilience are more important to students who are facing risks—even when such risks are identified from an external perspective.

There are a number of limitations to this study. One limitation is the small size of the high-risk group. With just 41 students out of 606 students being classified as high-risk the finding may be idiosyncratic to this sample. In addition, both the measure of risk and the measure of academic success used are crude measures. The risk measure of low socioeconomic status is measured by eligibility for free or reduced-price lunch which in this study is dichotomized with students who are eligible for free or reduced-price lunch in one category and students who are not eligible in another category. In this study, this variable was dichotomized grouping students who had any eligibility into one group. This dichotomization of the measure takes away much of the variability in the measure.

For instance there are very real differences between a student who is from a family with an income far below the poverty line and a student who is from a family that is slightly above the poverty line, but both of these students would be labeled as low SES. Similarly, the measure of academic success used is also dichotomized with students meeting or exceeding the standards categorized in one group and students who fail to meet the standards in the academic risk group. However, this assessment is a criterion-referenced test, and as such one would expect the majority of students to meet the standards for that particular grade. Even within those students who met the standards there are possibly many children who are struggling with their mathematics course work. Therefore, future studies should investigate the relationship between student perceptions of academic resilience and academic outcomes using both a more fine-grained measure of socioeconomic status and a more fine-grained measure of academic achievement. Additionally, future studies should attempt to include a larger number of students in the risk groups.

However, even with these limitations, the first model with the full sample of students showed that academic resilience explained a statistically significant portion of the variation. The results for the high-risk group was particularly interesting as it suggests that interventions for students at risk—both based on prior academic failure and coming from a low socioeconomic background—might be beneficial for these students. It would be important to investigate further what types of supports lead to better academic outcomes and the mechanisms through which this occur. Is it by building up student self-perceptions of their academic resilience? The next study takes on this task of

seeking to understand the role academic resilience plays in a larger framework of beliefs, motivation and outcomes.

Chapter Five: Exploring the Mediating Role of Academic Resilience

Some students are able to maintain competence or even excel in the face of academic challenges, whereas others are not. Resilience refers to this positive response to challenge (Yeager & Dweck, 2012). Gordon and Song (1994) write regarding resilience:

> A wide variety of factors operate to influence the achievement of success in persons against whom the odds are stacked. No single factor can be identified which is necessary or sufficient to produce success. Persons who achieve success against the odds appear to do so through deliberate and fortuitous orchestrations of many personal, environmental, and situational factors. (p. 41)

From a social cognitive perspective, the focus of studies of resilience is on the interrelationship of person, environment, and behavior. The person, environment and behavior form a triadic process with each interacting reciprocally (Bandura, 1989). Person characteristics play a role in shaping the interactions that occur between the person and the environment (Crockett & Crouter, 1995). Similarly, characteristics of the environment help to shape person characteristics. Bandura's SCT (1989) represented a move away from the behavioral views that were held by many psychologists, in which a stimulus was thought to linearly cause a particular behavior. In SCT, people are viewed as agentic beings. Bandura (2001) writes:

> To make their way successfully through a complex world full of challenges and hazards, people have to make good judgments about their capabilities, anticipate the probable effects of different events and courses of action, size up

> sociocultural opportunities and constraints, and regulate their behavior accordingly. (p. 3)

Within this theoretical framework, the perceptions—the thoughts, goals, beliefs, and values—that a person holds become particularly important as these form the basis of actions (Schunk, Pintrich, & Meece, 2002). As Buehl and Alexander (2009) write, "beliefs are at the core of the current motivation literature" (p. 480). In SCT, it is possible for learning to have taken place without an observable behavioral change. In other words, it is possible that learning has taken place even without the display of the particular skill. Rather, the theory focuses on the use of skills and how their use is affected by both personal and situational factors (Schunk, Pintrich, & Meece, 2002). In this way, we can understand resilience as a skill set that may be particularly exhibited in the face of challenges. But its lack of expression does not deny its existence within a person.

Academic Resilience

Academic resilience is often defined as "the heightened likelihood of success in school and in other life accomplishments, despite environmental adversities, brought about by early traits, conditions, and experiences" (Wang, Haertel, Walberg, 1994, p. 46). Researchers investigating academic resilience have primarily focused on poor and/or minority students. Much of the research on resilience grew out of studying populations that were statistically at risk and then seeking to discover the factors that differentiate those within the risk group who are successful from those within the risk group who are not successful. While these studies have highlighted the differences between students from at-risk backgrounds who are academically successful and students from at-risk

backgrounds who are not academically successful, they have failed to account for the individual student perspective. Additionally, by identifying resilience based on outcomes, the population of children to whom the study of resilience applies is limited. However, I argue that resilience broadly defined as the ability to handle challenges is critical for all students for as Brooks and Goldstein (2001) write "no child is immune in this environment" (p. 2). Brooks and Goldstein (2001) argue that all children face risk at some point in their development and that "a resilient mindset, the ability to cope with and overcome adversity, is not a luxury or a blessing possessed by some children but an essential component for all children" (p. xi). As such, helping children develop the tools—the mindsets, the self-regulation strategies, and the support systems—that are needed to bring about positive academic outcomes, even in the face of challenges is important for all children. Finally, an outcome-based approach to identifying resilience precludes the possibility of identifying students who are not handling challenges well, and thereby limits the chances for timely intervention.

Mindsets

The beliefs that individuals hold influence their thinking, their levels of motivation, and ultimately their behavior (Buehl & Alexander, 2005). Therefore, in seeking to add to an understanding of resilience, it is important to investigate the beliefs that might contribute to it. Not only is it necessary to provide students with skills to effectively handle challenges, but "attention must also be paid to the psychology underlying adolescents' resilient responses to academic and social challenges" (Yeager & Dweck, 2012, p. 302). Yeager and Dweck (2012) write that an important part of this psychology is the mindset that a student holds. While the idea of implicit theories can be

applied to various context, the focus here is on implicit theories of intelligence. There are two types of implicit theories of intelligence a student can hold: an incremental theory of intelligence, also referred to as having a growth mindset, or an entity theory of intelligence, also referred to as having a fixed mindset. A person who holds a *fixed mindset* or holds an *entity theory of intelligence* believes that intelligence is immutable—either one is smart or not (Dweck, 2006). A person who holds a *growth mindset* or an *incremental theory of intelligence*, on the other hand, believes that intelligence can be changed based on one's effort (Dweck, 2006, p. 7). The role that mindsets play in promoting resilience is important as mindsets are changeable, and the type of mindset one holds has implications for resilience (Yeager & Dweck, 2012). In a study of 7th grade students, Blackwell, Trzesniewski, and Dweck (2007) found that holding an incremental theory of intelligence predicted an upward trajectory in grades over the two years of middle school. This was in comparison to the flat trajectory of grades for students who ascribed to an entity theory of intelligence. They also found in an intervention study that the 7th graders who were taught an incremental theory saw the trajectory of their grades change from a decline to an increase, whereas for those students in the control group their grades continued to decline. These studies highlight the need for investigating further the relationship between the implicit theories of intelligence that a student holds and that student's academic outcomes.

Self-regulated learning

"Self-regulation theory…focuses attention on *how* students personally activate, alter, and sustain their learning practices in specific contexts" (Zimmerman, 1986, p. 307). Self-regulation theory applied to the academic context has come to be referred to

as self-regulated learning. Both self-regulation more generally and self-regulated learning more specifically draw on a number of different theoretical perspectives (Pintrich, 1999). Self-regulated learning, in general, refers to the active monitoring of one's motivation, cognition, and behavior within an academic setting (Pintrich, 1999; Wolters & Taylor, 2012). In other words self-regulated learning refers to the ability of a student to monitor and control the processes of his learning—this ranges from regulating his motivation, activating learning strategies, assessing one's knowledge, and controlling one's behavior and environment in an effort to bring about a more positive academic outcome. Self-regulated learning has been shown to be associated with academic achievement (Zimmerman & Martinez-Pons, 1986).

Self-regulation skills are on the "short list" of commonly observed predictors of resilience in young people (Masten, Herbers, Cutuli, & Lafavor, 2008). Martin and Marsh (2006) write that "Work in self-regulation and goal setting provides direction for enhancing students' *planning* and *persistence*, two other keys to students' academic resilience" (p. 277). Linnenbrink (2005) includes both quality and quantity of self-regulation in her conceptualization of cognitive engagement. Quality of self-regulation refers to how often students "planned, monitored, and checked their understanding when working on their math work" (p. 201) and quantity of self-regulation refers to "persistence behaviors" (p. 201). Linnenbrink (2005) found positive associations between mastery goals and both the quality and quantity of self-regulation, and that strongly endorsing mastery goals was associated with higher math scores.

Purpose

This chapter focuses on the relationships among student implicit theories of intelligence also referred to as mindsets, their self-regulation strategies, academic resilience, and achievement in mathematics. I investigate the role of academic resilience as a mediator between student beliefs (mindsets) and outcomes (self-regulation strategies and mathematics achievement). This study addresses the following research question:

1. What is the role of academic resilience in mediating variables related to mindsets, self-regulated learning and academic achievement?

Hypothesis

Buehl & Alexander (2009) write that "beliefs are at the core of the current motivation literature" (p. 480). Therefore, I hypothesize that beliefs influence the motivational states of students. Their belief about intelligence as being malleable or not, influences their ability to handle academic challenges. Students who hold a belief that intelligence is malleable will be more likely to keep working, to seek out additional resources, and to maintain their academic goals, even in the face of challenges. Students who hold a belief that intelligence is immutable would be hypothesized to be less likely to persist in the face of challenges, as this belief leads them to thinking that it does not matter how hard they try or how much effort they put in. Their success or failure is based upon their innate ability, and thus effort will not change this.

How motivated students are to persist in the face of challenges, here measured by academic resilience, will influence the strategies they use to enhance their learning, here measured by the quality and quantity of self-regulation. The use of these strategies will then influence their academic outcomes. A stylized diagram of this is shown in Figure 4.

The two beliefs—incremental and fixed—that students may hold about intelligence are included as independent variables. Student beliefs are then hypothesized to predict student motivation and ability to persist in the face of challenges—here measured by the three sub-components of academic resilience: academic buoyancy, access to support, and future goals. These are then hypothesized to influence strategies for learning represented by the quantity and quality of self-regulation, which then influence student academic outcomes as measured by performance on a statewide standardized assessment in mathematics.

Method

Participants

The data were collected as part of a larger study investigating the relationships between a number of motivational variables and academic achievement in the context of a middle school (grades 7 and 8) mathematics classroom. The study includes 606 7^{th} (n = 289) and 8^{th} (n = 315) grade students. Two students were missing grade level information. Eighty-seven students (15%) did not report their gender. Of those who did, 46% were male and 54% were female. All students attended the same middle school located in the southeastern United States. The school is designated a Title I school, which means that a preponderant portion of its student population qualifies for free or reduced-price lunch, which in this study is used as a proxy for socioeconomic status. Sixty-seven percent of the students included in this study were eligible for free or reduced-price lunch. Seventeen percent of the sample did not identify their racial background. Of those who did, 45% identified as Black/African-American, 27% identified as Hispanic/Latino, 15% as White, and 13% as Other, Asian, or Native-American.

Measures

Mathematics Pre-Test. This was measured based on student performance on a criterion-referenced statewide standardized mathematics assessment taken in the spring of the year prior to data collection. Overall scores ranged from 760 to 950 with a mean of 831.91 (SD = 28.76). For 7th grade students the mean score was 828.7 (SD=28.9) and for 8th grade students the mean score was 834.9 (SD=28.5). Scores above 800 indicate that the student has met the acceptable standards for their grade level.

Mathematics Post-Test. This was measured based on student performance on a criterion-referenced statewide standardized mathematics assessment taken in the same year as data collection. Overall scores ranged from 755 to 990 with a mean of 832.13 (SD = 33.40). For 7th grade students, their mean score on the post-test was 842.0 (SD = 29.2). For 8th grade students, their mean score on the post-test was 823.0 (SD = 34.5). Scores above 800 indicate that the student has met the acceptable standards for their grade level.

Self-report measures. The format for all self-report items was a 6-point scale ranging from 1 (*Strongly Disagree*) to 6 (*Strongly Agree)*. All items were written to be specific to the subject area of mathematics. All items can be found in Appendices B, C and D. Summary statistics for each of the self-report measures can be found in Table 7.

Implicit Theories of Intelligence (Mindsets). Student implicit theories of intelligence or the type of mindset they have was measured by the implicit theories of intelligence scale. The scale included 4 items, of which two items measured whether a student subscribed to an incremental theory of intelligence (a growth mindset), and two items assessed whether a student held an entity view of intelligence (a fixed mindset)

(Dweck, 1999). A sample item for the growth mindset is "The more I learn, the better I will be in math." A sample item for the fixed mindset is "I will never get good grades in math." The reliability of these sub-scales were adequate with alpha coefficients of 0.65 for each.

Self-regulated Learning. Self-regulated learning was measured by the self-regulated learning scale, which consists of 8 items. These items were taken from Linnenbrink's (2005) cognitive engagement scale and includes four items that measure the quality of self-regulation and four items that measure the quantity of self-regulation. The quality of self-regulation can be thought of as the *process* of self-regulation—how often does a student undertake specific strategies such as planning, monitoring, and checking their understanding when completing math tasks. A sample item for quality of self-regulation is "When I do math, I check over my work." The quantity of self-regulation refers to student perseverance or persistence when completing math tasks. A sample item is "Even when I don't want to work on math, I force myself to do the work." Linnenbrink (2005) obtained reliability coefficients of .76 for quality of self-regulation for both the pretest and the posttest included in her study. She obtained reliability coefficients of .60 and .72 for quantity of self-regulation for the pretest and posttest respectively. In this study the scales also exhibited good reliability with $\alpha = 0.75$ for the quality of self-regulation and $\alpha = 0.89$ for the quantity of self-regulation subscales.

Academic Resilience. Student self-perceptions of academic resilience was measured by the academic resilience in mathematics (ARM) scale which was constructed to measure three areas that were hypothesized to be part of academic resilience: academic buoyancy—which refers to "students' ability to successfully deal with academic setbacks

and challenges that are typical of the ordinary course of school life" (Martin & Marsh, 2008, p. 54), access to support, and future goals (Ricketts, Engelhard, & Chang, 2015). The scale included 9 items and had good reliability ($\alpha = 0.83$).

Procedure

Students completed the survey over two days during their "home room" period, and returned surveys to the teacher who was responsible for this period. The teachers then returned the surveys to the research team. Consent was received from the parents of all students who participated in the survey. Assent was received from all the students.

Data Analysis

Structural equation modeling was used to investigate the relationships among the variables that measured belief, motivation, and math achievement. All analyses were performed using LISREL 9.1 software (Joreskog & Sorbom, 2012). The data analysis followed the steps suggested by Schumacker and Lomax (2004) for structural equation modeling: model specification, model identification, model estimation, model testing, and model modification. Before testing the full measurement model, confirmatory factor analyses were performed on each of the scales individually.

Measurement Models

Each of the scales represents a latent construct with each construct measured by multiple items. The scales included in this analysis were academic resilience, self-regulated learning, and implicit theories of intelligence. Two different models were fit for the academic resilience in mathematics scale: the first was a one factor model, and the second was a three-factor model with the three factors being academic buoyancy (4 items), access to support (2 items), and future goals (3 items). The self-regulated learning

scale was hypothesized to have two sub-factors representing quantity of self-regulated learning (4 items) and quality of self-regulated learning (4 items). The implicit theories of intelligence was hypothesized to have two sub-factors representing a fixed mindset (2 items) and a growth mindset (2 items). A confirmatory factor analysis was performed separately on each scale to investigate its fit to the hypothesized structure. After fitting a measurement model for each scale a full measurement model was fit which included the scales, as well as the pre-test and post-test variables. This model was tested for adequate fit, and modifications in line with the theoretical understanding of the relationships of the constructs made as necessary to improve the fit.

Model specification

Model specification refers to the theoretical framework that guides the investigation (Schumacker & Lomax, 2004). In this study, social cognitive theory forms the theoretical framework. The general hypothesis is that belief variables predict motivational variables which then predict outcome variables (see Figure 4). In this study beliefs are represented by the implicit theories of intelligence that a student holds—that is whether a student holds an incremental or an entity view of intelligence. The motivational variable included is student self-perceptions of academic resilience—broken out into academic buoyancy, access to support, and future goals. Outcomes include the use of self-regulation strategies—broken out into quality and quantity of self-regulated learning, and ultimately math achievement as measured by student performance on a statewide standardized mathematics assessment.

Model identification

It is important that the model we specify is one that can theoretically be estimated (Kline, 2011). This is necessary to ensure that a unique set of parameter estimates can be obtained from the sample variance-covariance matrix. There are 35 observed variables included in this study, which means that the number of values in the variance-covariance matrix is equal to 630. This is far greater than the number of free parameters that need to be estimated by the model.

Model estimation

This step involves evaluating model fit, interpreting the parameter estimates, and considering equivalent or near-equivalent models (Kline, 2011). This includes first fitting and testing the measurement model as described under the measurement model section. After acceptable fit has been obtained for the measurement model, then the hypothesized paths are included and the structural equation model tested. Fit indices such as RMSEA and CFI were used to compare the hypothesized model with alternative models at each step of the model building process. This includes the confirmatory factor analyses for each individual scale, the full measurement model, and the structural equation model.

Model testing and modification

If the fit indices are acceptable, then the model has been accepted by the sample variance-covariance matrix. However, if the fit indices are not acceptable, then modifications that are in line with the theoretical framework can be made in an effort to achieve a better fit of the model to the data (Schumacker & Lomax, 2004). This approach was taken in the analyses presented herein. Alternative models that fit the theoretical framework were tested.

Results

Validation of the Full Measurement Model

Fit indices for each of the confirmatory analyses for the three scales: implicit theories of intelligence, academic resilience in mathematics, and self-regulated learning can be found in Table 8.

The path diagram for the implicit theories of intelligence scale can be seen in Figure 5. The correlation between the two sub-factors incremental theories and entity theories is negative (r = -0.50) as would be expected given that these are measuring two different ends of the theories of intelligence continuum.

The path diagram for two models of the academic resilience in mathematics scale can be seen in Figures 6 and 7. A one-factor scale was tested first, however the fit was poor. Based on both the modification indices and theoretical considerations, a number of modifications were made. Modifications included dropping two items—Item 7 and Item 9. In addition, an error covariance was added between Item 5 and Item 8. Figure 6 shows the path diagram for the one-factor model for academic resilience after these modifications. Figure 7 shows a three-factor model based on the three types of questions that were included in the construction of the scale: academic buoyancy, access to support, and future goals.

The path diagram for the self-regulated learning scale can be seen in Figure 8. The correlation between quality and quantity of self-regulated learning was fairly high (r = .90) which suggests that these subscales might not be entirely distinct. However, for theoretical reasons, I continued to use the two subscales separately. Additionally, the confirmatory factor analysis model shows that a two-factor model can be supported.

Two full measurement models were tested: one using the one-factor academic resilience scale with modifications, and the second using the three-factor academic resilience scale. In each case, an error covariance between quality and quantity of self-regulated learning was added. These results can be seen in Table 9. The two path diagrams can be seen in Figures 9 and 10. The correlations among the latent variables included in the model can be seen in Table 10.

Validation of the Structural Model

After getting acceptable fit for the measurement model, the hypothesized paths were tested. The major goal was to test whether our hypothesized path of beliefs influencing motivation influencing outcomes was supported by the model. The two models tested here were both built from this hypothesis. As the fit of both models was comparable, the structural equation model including the one-factor academic resilience scale was tested first (Model 1). The second model tested the structural equation model that included the there-factor academic resilience scale was then tested (Model 2). Figure 11 shows the structural equation model diagram for Model 1 and Figure 12 shows the structural equation model diagram for Model 2. In both models paths are included that go from beliefs (incremental theory of intelligence and entity theory of intelligence) to academic resilience in mathematics (in the case of Model 2 this includes academic buoyancy, access to support, and future goals) to self-regulated learning (quantity and quality) to academic outcomes. There are also paths from each variable to academic outcomes, including a path from prior test scores to post-test scores. The fit statistics for each of these models can be seen in Table 11.

Discussion

The results showed that both models had comparable fit. Model 2, which included a three-factor structure for academic resilience had overall better statistics (see Table 11), however Model 1 was retained for a number of reasons. First, Model 1 included a one-factor structure of academic resilience, which is more parsimonious and therefore more easily interpreted. Additionally, while the scale drew from a number of different item types, it was constructed to be used as a one-factor scale. Therefore, given comparable fit statistics for both models, Model 1 was retained. The discussion that follows is based on the retained model—Model 1 (Figure 11).

Model 1 (see Tables 12 and 13) lends support to the hypothesis of motivational beliefs, in this case academic resilience, mediating the relationship between beliefs and mathematics achievement. Holding an entity theory of intelligence was negatively related to both academic resilience and academic performance ($\beta = -0.198$, $p < .05$; $\beta = -0.230$, $p < .05$). In other words, the more a student believed that intelligence is a fixed quality the less well they did academically, and the less likely they were to report that they persisted when faced with challenges to their academic success. This relationship was in line with prior hypotheses. Holding an incremental theory of intelligence was positively related to academic resilience ($\beta = 0.504$, $p < .05$) as well as to both quantity and quality of self-regulated learning ($\beta = 0.340$, $p < .05$; 0.352, $p < .05$). Academic resilience was positively related to both quantity and quality of self-regulated learning ($\beta = 0.674$, $p < .05$; $\beta = 0.699$, $p < .05$). Of the two factors of self-regulated learning, only quantity of self-regulated learning had a statistically significant relationship with post-test scores ($\beta = 0.290$, $p < .05$), suggesting that the quantity of self-

regulated learning—that is how much a student self-regulates one's learning—is more important to academic outcomes than the process by which they self-regulate their learning. The lack of a statistically significant effect of holding an incremental theory of intelligence on post-test scores was a bit surprising as it was hypothesized that holding a belief that intelligence is changeable should influence post-test scores. There was also not a statistically significant effect of academic resilience on post-test scores.

The retained model, Model 1, adds to the understanding of how academic resilience operates to influence academic achievement in students, and provides support for a mediating role between beliefs and academic outcomes. It also raises the question as to why holding an incremental view of intelligence does not have the hypothesized positive relationship with academic achievement. Perhaps as suggested by this model, holding an incremental theory of intelligence, in and of itself does not lead to improved academic outcomes. Rather, the relationship between holding an incremental theory of intelligence and academic outcomes is mediated by other variables, in this case academic resilience and quantity of self-regulated learning.

There are a number of limitations to this study. The fit of the model, while acceptable was not great, suggesting areas for further refinement of the model, the measures or both. For instance, the measures for incremental and entity theory of intelligence were each measured by only two items, whereas most texts on structural equation model recommend at least three measures for each construct (Kline, 2011; Schumacker & Lomax, 2004). Additionally, some of the loadings were lower than the 0.70 that is typically recommended for good instruments (Kline, 2011). In addition, it should be kept in mind that this study consisted of students from African American and

Hispanic students and low-income backgrounds. Therefore, the relationships found in this study may not be applicable to all students. However, the findings herein may be particularly applicable to a population of students similar to the ones in this sample, as many students from these backgrounds struggle academically, particularly through the middle school transition.

Chapter Six: Discussion

This dissertation adds to the literature on academic resilience by first situating it within the theoretical framework of social cognitive theory. Second, by focusing on self-perceptions of academic resilience, this dissertation opens up the study of handling academic challenges to all students, not just those facing observable risk. In so doing, the population of students who are able to benefit from findings regarding resilience is opened to all students.

Findings from Chapter Three highlight the importance of paying attention to student perceptions, and that categorizing students based on observable pre-determined criteria may not reflect the reality as it is interpreted by students. The results of this chapter also draw our attention to the unique needs of students in various risk groups. For instance, the students in Group I—that is, the students who were not eligible for free or reduced-price lunch and who were not doing well academically—reported significantly different self-perceptions of academic resilience from any of the other groups. Given the small size of this group (n = 9), this finding should not be over-interpreted until additional studies can support this finding. However, it does provide those who work with children—teachers, counselors, and administrators—with information that these students may have different self-perceptions of their ability to handle challenges than other students and may need interventions particularly suited to their circumstances. The conclusion here being that perception matters. For as Gordon and Song (1994) ask: "If it is my behavior that we are trying to explain, whose perceived reality is valid as an independent variable?" (p. 31). This study lends support to the idea that it is the perception of the individual that matters most.

Findings from Chapter Four highlight the importance of student perceptions of academic resilience, and that it is particularly important for those students facing observable risk. In this dissertation, these students were ones who were both low-income and had experienced prior academic failure. For these students, being able to handle challenges, having knowledge of support systems, and having goals for their academic future—the sub-factors that comprise academic resilience as operationalized throughout this dissertation—were particularly important in explaining their academic achievement. For the entire group of students, self-perceptions of academic resilience explained about 4% of variation in post-test scores. When stratified by risk groups, the variation in post-test scores explained by academic resilience in the high-risk group was 20%. This suggests that having interventions focused on resilience building does not hurt those who may not particularly need it, but may be critical for those who do.

Chapter Five integrated academic resilience within the larger framework of social cognitive theory, investigating the relationships between beliefs, motivations, and academic outcomes. The findings from this chapter provide support for the basic model of beliefs influencing motivation, which then influences academic outcomes. There are some particularly salient findings including the lack of a direct relationship between holding an incremental theory of intelligence and post-test scores, and the lack of a significant relationship between the quality of self-regulated learning and post-test scores. Linnenbrink (2005) found a much smaller correlation between post-test quality of self-regulation and post-test scores ($r = .03$, $p < .05$) than between post-test quantity of self-regulation and post-test scores ($r = .21$, $p < .05$). Therefore our results are somewhat in line with her findings. Yet, it deserves to be explored further why given the importance

of self-regulated learning on academic outcomes, there is not a stronger relationship between the quality of such self-regulation and academic outcomes. The model also suggests that academic resilience plays a mediating role between beliefs and academic outcomes. Some of these findings raise perhaps more questions than answers with regards to the ways in which beliefs work to bring about academic outcomes. Is it all through indirect paths as suggested by the path from incremental theory of intelligence to resilience to quantity of self-regulated learning, and ultimately to academic outcomes? Or is there a direct link to academic outcomes as suggested by the negative relationship between holding an entity theory of intelligence and post-test scores? Is holding an entity theory of intelligence more detrimental to academic outcomes, than holding an incremental theory of intelligence is positive? In other words, is simply *not* believing that intelligence is fixed what is important? Additional research is warranted to more fully understand the mechanisms through beliefs and motivations interact to bring about academic outcomes in this middle school population.

By focusing on academic resilience, and particularly self-perceptions of academic resilience, we can come to a better understanding as to how individuals are able to overcome the challenges they face with an eye to informing effective intervention for those facing similar risks (Masten, 1994). Focusing on resilience does not mean that we ignore those for whom the educational system as it exists today is unsuccessful. In fact, by focusing our attention on resilience we are able to determine factors that would be beneficial for all students. The risks a student faces have not been forgotten. Nor have the factors or systems that cause such risks been absolved of their responsibility, for as Garbarino (1992) cautions us that "the fact that humans *can* survive in the face of these

risks should not be enough to excuse or rationalize the threats that those risks present" (pp. 63-64). In fact we are reminded to be mindful of the toll exacted on individuals due to the extraordinary effort required by some to overcome the circumstances of their background. We are reminded that resilience is not a personality trait—a person is not resilient or non-resilient. A student can be aided in developing a resilient mindset, building up resources that would aid that child should she or he experience challenges to maintaining academic success. A successful academic outcome in the face of challenges does not just occur, but rather is the outcome of the interaction of personal factors, the environment, and behaviors—the three prongs in Bandura's triad. Gordon & Song (1994) remind us that no one achieves such outcomes singlehandedly:

> A wide variety of factors operate to influence the achievement of success in persons against whom the odds are stacked. No single factor can be identified which is necessary or sufficient to produce success. Persons who achieve success against the odds appear to do so through deliberate and fortuitous orchestrations of many personal, environmental, and situational factors. (p. 41)

The goal of those who work with our children is to help bring about the fortuitous set of factors that will allow children to achieve academic success, no matter the odds. This could involve providing additional support to students who are seen to be struggling academically, and ensuring that such students are aware of such resources. For simply providing resources are not enough if a student does not know that such resources exist, does not know how to access such resources, or does not have the ability to access such resources.

Limitations & Areas for Future Research

As mentioned within each of the three chapters, there are a number of limitations that should be kept in mind when interpreting the results from these studies. The sample of the risk groups in this dissertation was small, which may limit the inferences that can be drawn regarding the importance of academic resilience for students facing observable risk. The measures used for observable risk—socioeconomic status and poor performance on a statewide standardized mathematics assessment—were not fine-grained enough to distinguish greatly between students. In addition, this study uses one sample from one middle school in one part of the country. Replication studies in other grade levels, in other schools, and in other parts of the country and the world are needed to determine if the findings are robust.

Future research should continue to explore the factor structure of the academic resilience in mathematics scale, looking to the literature to determine if there are other items that should be included in attempting to fully measure students' academic resilience. Such research could include qualitative studies designed to investigate how students perceive the academic risks in their lives, and the tools that they use to buttress such risk. Such research could bolster the validity of an academic resilience scale. It would also be useful to know how well the scale can be adapted to other academic domains. Is academic resilience in mathematics quantitatively and qualitatively different from academic resilience in other academic domains? Can a general academic resilience scale be conceptualized and be used meaningfully in analyses?

Socioeconomic status measured by student eligibility for free or reduced-price lunch was used throughout the dissertation. While it is one of the most commonly used

measures due to the ease of obtaining such information, it is "conceptually problematic." (Sirin, 2005, p. 444) as it does not fully capture the economic well-being of students.

Therefore additional research is needed using more exhaustive measures of socioeconomic status, such as family income.

Future research should also include larger groups of high-risk students in order to explore further the explanatory power of academic resilience on academic achievement. While the researchers attempted to do such analyses, the sample sizes of the high-risk group were much too small to make meaningful comparisons between high-risk and low-risk students.

An additional area of future research is delineating between closely related constructs such as grit and hardiness. Concerns have been raised regarding whether there is in fact the need for another construct to describe such behavior (Bartelt, 1994; Kaplan, 2005). Kaplan (2005) questions whether resilience is the same or similar to other constructs such as hardiness. As described by Kobasa (1979), people who are hardy have three general characteristics: control, commitment, and challenge. Grit is defined as "perseverance and passion for long-term goals" (Duckworth, Peterson, Matthews, & Kelly, 2007, p. 1087). While these constructs are certainly related to resilience and may in fact be predictors of resilience, their focus is solely on characteristics of the person. The conceptualization of academic resilience used throughout this dissertation includes not just personal characteristics, but also characteristics of the environment as characterized by Social Cognitive Theory. Such a conceptualization acknowledges that while individuals may be able to overcome challenges on their own, having access to support for many is critical and should not be discounted. However, further studies

should investigate the degree of overlap among these constructs in an effort to further clarify the process through which students are able to overcome challenges to their academic success.

The results of this dissertation show that while more research is needed, a focus on academic resilience is a promising avenue of research for providing answers to helping all children succeed, and particularly may be even more important for students who are already facing risks to their academic success. Continued research in this area is warranted as the findings may have widespread implications for the ways in which interventions are provided to children, as well as the types of interventions that are provided.

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Table 1

Classification Matrix used for Outcome-based Academic Resilience

Presence of Risk Factor	Academic Achievement	
	LOW	HIGH
NO	Group I	Group II
YES	Group III *Non-resilient*	Group IV *Resilient*

Table 2

Outcome-based Academic Resilience

Eligibility for Free or Reduced-Price Lunch	Statewide Mathematics Performance Standards	
	DOES NOT MEET STANDARDS	MEETS OR EXCEEDS STANDARDS
Not eligible	Group I (n = 9)	Group II (n = 170)
Eligible	Group III (n = 43)	Group IV (n = 306)

N = 528.

Table 3

Summary Statistics for Facets Analyses

		Students	Items	Outcome-based Resilience
Measures				
	M	.77	.00	.00
	SD	1.04	.56	.14
	Count	528	9	4
Infit				
	M	1.02	1.08	1.07
	SD	.72	.32	.06
Outfit				
	M	1.04	1.04	1.07
	SD	.80	.19	.04
Reliability of Separation		.78	.99	.83
χ^2 Statistic		2037.8*	977.3*	14.3*
Degrees of freedom		527	8	3

*$p < .01$

Table 4

Mean Contrasts for ARM Scale by Outcome-based Resilience Groups

	Group I	Group II	Group III	Group IV
Group I		-0.36	-0.32	-0.29
Group II	-3.53*		0.04	0.07
Group III	-2.86*	0.74		0.03
Group IV	-2.84*	2.47*	0.56	

Note. This table shows the pair-wise comparison of the mean student perception of academic resilience scores as measured by the ARM scale between each of the outcome-based resilience groups. t-values are shown below the diagonal and logit differences are shown above the diagonal.
*$p < .05$

Table 5

Correlations of Variables included in Hierarchical Multiple Regression Analyses

	1	2	3	4	5
1. Risk Factor 1: Eligibility for Free or Reduced-Price Lunch (Dummy Variable, No=0, Yes=1)					
2. Risk Factor 2: Low prior mathematics achievement (Dummy Variable, No=0, Yes=1)	.11**				
3. Academic Resilience	-.04	-.05			
4. Mathematics Pre-Test	-.38**	-.43**	.08*		
5. Mathematics Post-Test	-.35**	-.27**	.22**	.69**	
Mean	.67	.08	4.46	831.94	832.11
SD	.47	.27	.94	28.85	33.45

Note: $N = 602$.
*$p < .05$. **$p < .01$.

Table 6

Hierarchical Regression Analyses Predicting Mathematics Achievement

Variables in equation	Full Model, Mathematics Achievement for All Students			Mathematics Achievement for Low-Risk Students[1]	Mathematics Achievement for High-Risk Students[2]
	Step 1	Step 2	Step 3		
Risk Factor 1: Eligibility for Free or Reduced-Price Lunch (Dummy Variable, No=0, Yes=1)	-.35**	-.33**	-.32**	---	---
Risk Factor 2: Low prior mathematics achievement (Dummy Variable, No=0, Yes=1)		-.23**	-.22**	---	---
Academic Resilience			.20**	.14	.45*
N		602		191	41
R^2	.12**	.18**	.22**	.02	.20*
Change in R^2		.05**	.04**		

Note. [1] Students identified as low-risk are students who are not eligible for free or reduced-price lunch, and whose prior performance on the statewide mathematics assessment met or exceeded the standards.
[2] Students identified as high-risk are students who are eligible for free or reduced-price lunch, and whose prior score performance on the statewide mathematics assessment failed to meet the standards.
**p < .01. **p < .001.*

Table 7

Descriptive Statistics for All Latent Variables

Variable	*n*	# of items	Mean	SD	Skew	α
Academic resilience	606	9	4.46	0.94	-0.61	0.83
Incremental theory of intelligence	496	2	4.91	1.12	-1.06	0.65
Entity theory of intelligence	494	2	2.02	1.41	1.52	0.65
Quality of self-regulated learning	606	4	4.12	1.09	-0.33	0.75
Quantity of self-regulated learning	606	4	4.34	1.25	-0.57	0.89

Table 8

Summary of Confirmatory Factor Analyses

Measurement Model	# of items	χ^2	df	RMSEA	SRMR	GFI	AGFI	CFI
Implicit theories of Intelligence	4	1.402	1	0.026	0.009	0.999	0.988	0.999
Academic Resilience with 1 factor	9	403.81	27	0.152	0.087	0.849	0.748	0.869
Academic Resilience with 1 factor after modifications	7	52.949	13	0.071	0.046	0.976	0.947	0.980
Academic Resilience with 3 factors	9	43.179	24	0.036	0.027	0.984	0.970	0.993
Self-regulated learning	8	63.003	19	0.062	0.027	0.975	0.953	0.990

Table 9

Summary of Full Measurement Models

Measurement Model	χ^2	df	RMSEA	SRMR	GFI	AGFI	CFI
Full measurement model 1	479.452	169	0.055	0.052	0.927	0.900	0.977
Full measurement model 2	409.696	196	0.042	0.034	0.944	0.921	0.986

Table 10

Correlation Matrix of Latent Variables in Full Measurement Model 1

Variable	1	2	3	4	5	6	7
1. Incremental theory of intelligence	1.000						
2. Entity theory of intelligence	-0.519	1.000					
3. Academic Resilience	0.607	-0.460	1.000				
4. Quantity of self-regulated learning	0.409	-0.310	0.674	1.000			
5. Quality of self-regulated learning	0.424	-0.321	0.699	0.909	1.000		
6. Prior achievement in mathematics	0.059	-0.286	0.087	0.058	0.061	1.000	
7. Post achievement in mathematics	0.201	-0.432	0.220	0.210	0.168	0.692	1.000

Note. $N = 606$.

Table 11

Structural Equation Model Summary

	df	χ^2	RMSEA	SRMR	GFI	AGFI	CFI
Model 1	176	551.444	0.059	0.058	0.913	0.886	0.972
Model 2	208	490.312	0.047	0.041	0.934	0.912	0.982

Table 12

Unstandardized parameter estimates, standard errors, and standardized parameter estimates for the effects of the predictor variables on the outcome variables for Model 1

Estimates	Unstandardized coefficient	SE	Standardized coefficient
Paths			
Incremental --> Resilience	0.50	0.07	0.50
Incremental --> Post-test	0.02	0.05	0.02 ns
Entity --> Resilience	-0.20	0.06	-0.20
Entity --> Post-test	-0.22	0.05	-0.22
Resilience--> Quantity	0.67	0.06	0.67
Resilience --> Quality	0.70	0.06	0.70
Resilience --> Post-test	0.02	0.06	0.02 ns
Quality --> Post-test	-0.22	0.14	-0.22 ns
Quantity --> Post-test	0.29	0.12	0.29
Pre-test --> Post-test	0.62	0.62	0.62

Note. ns means not significant at $p < .05$.

Table 13

Standardized estimates of the direct, indirect, and total effects of the predictor variables on the outcome variables for Model 1

Predictor variables	Outcome	Direct	Indirect	Total
Incremental	Resilience	0.504	--	0.504
Incremental	Post-test	0.016 ns	0.028 ns	0.044 ns
Incremental	Quality	--	0.352	0.352
Incremental	Quantity	--	0.340	0.340
Entity	Resilience	-0.198	--	-0.198
Entity	Post-test	-0.219	-0.011 ns	-0.230
Entity	Quality	--	-0.139	-0.139
Entity	Quantity	--	-0.134	-0.134
Resilience	Quantity	0.674	--	0.674
Resilience	Quality	0.699	--	0.699
Resilience	Post-test	0.015 ns	0.041ns	0.056 ns
Quality	Post-test	-0.221 ns	--	-0.221 ns
Quantity	Post-test	0.290	--	0.290
Pre-test	Post-test	0.623	--	0.623

Note. ns means not significant at $p < .05$.

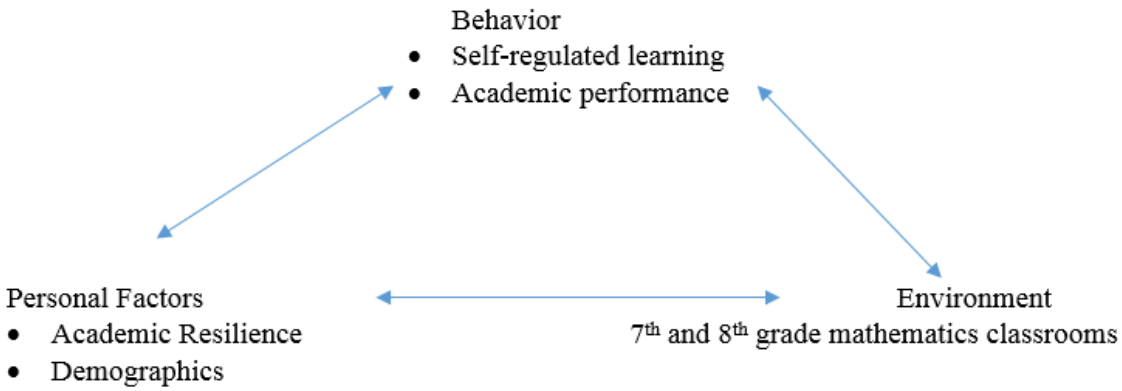

Figure 1. Social Cognitive Theory Framework

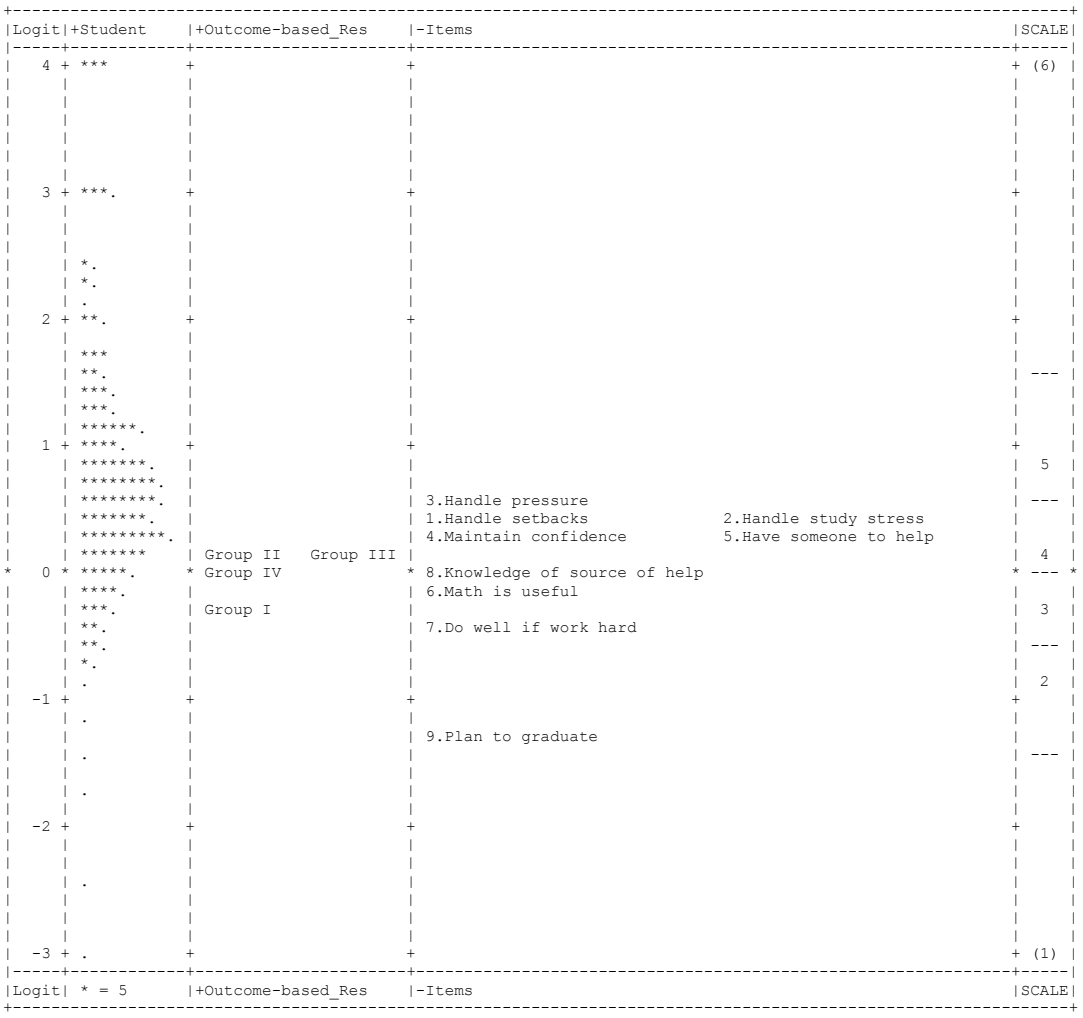

Figure 2. Variable Map showing the student locations, the locations of the outcome-based resilience groups, and the outcomes of each of the 9 items on the Academic Resilience in Mathematics scale.

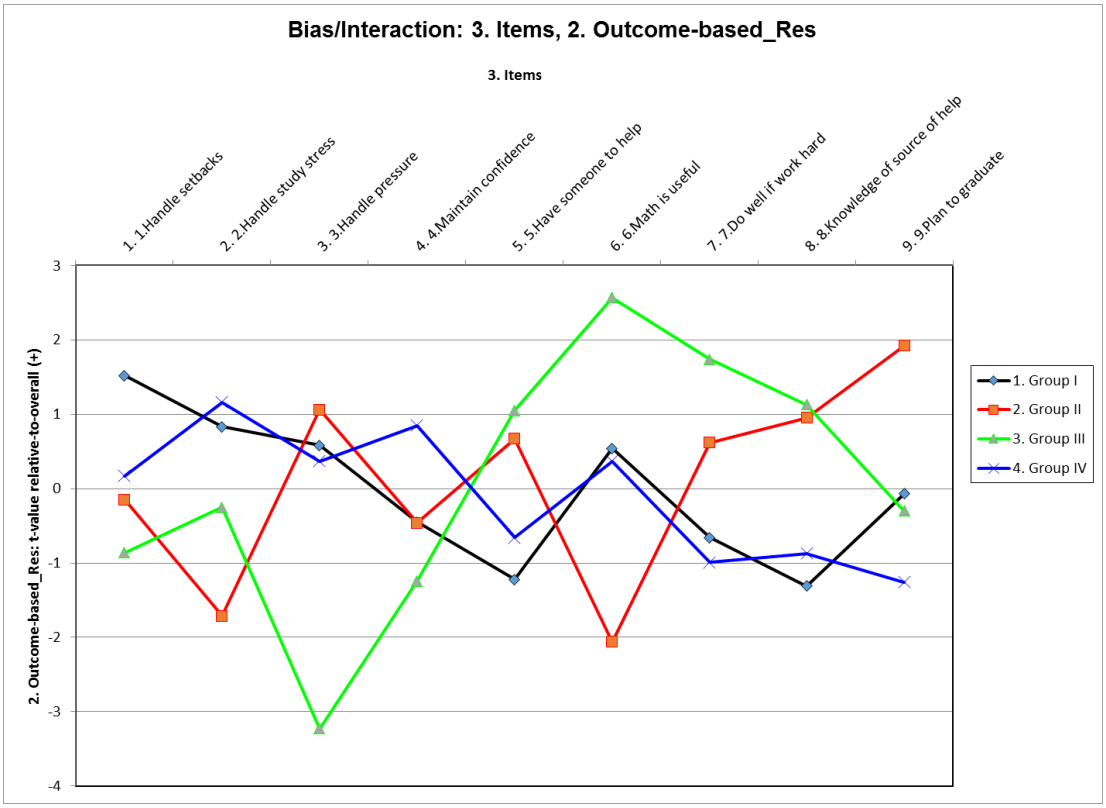

Figure 3. Bias/Interaction of Items and Outcome-based Resilience Groups. Points above +2 or below -2 are statistically significant.

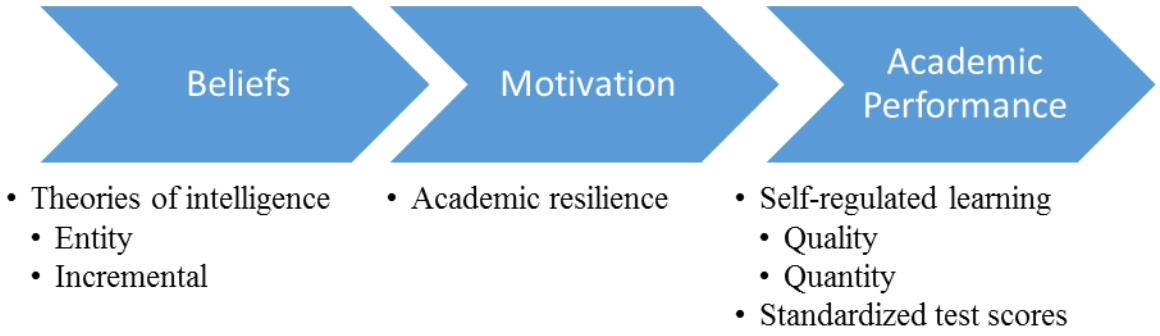

Figure 4. Hypothesized model of relationship between beliefs, motivation, and academic performance.

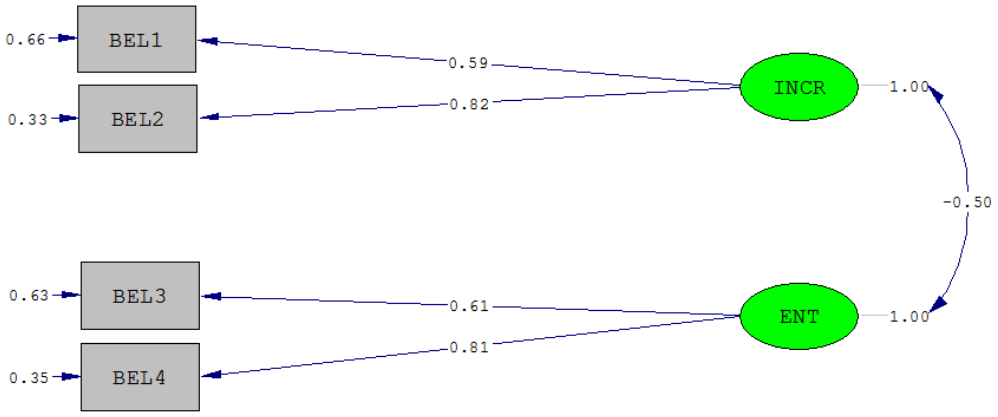

Figure 5. Path Diagram of Implicit Theories of Intelligence Scale

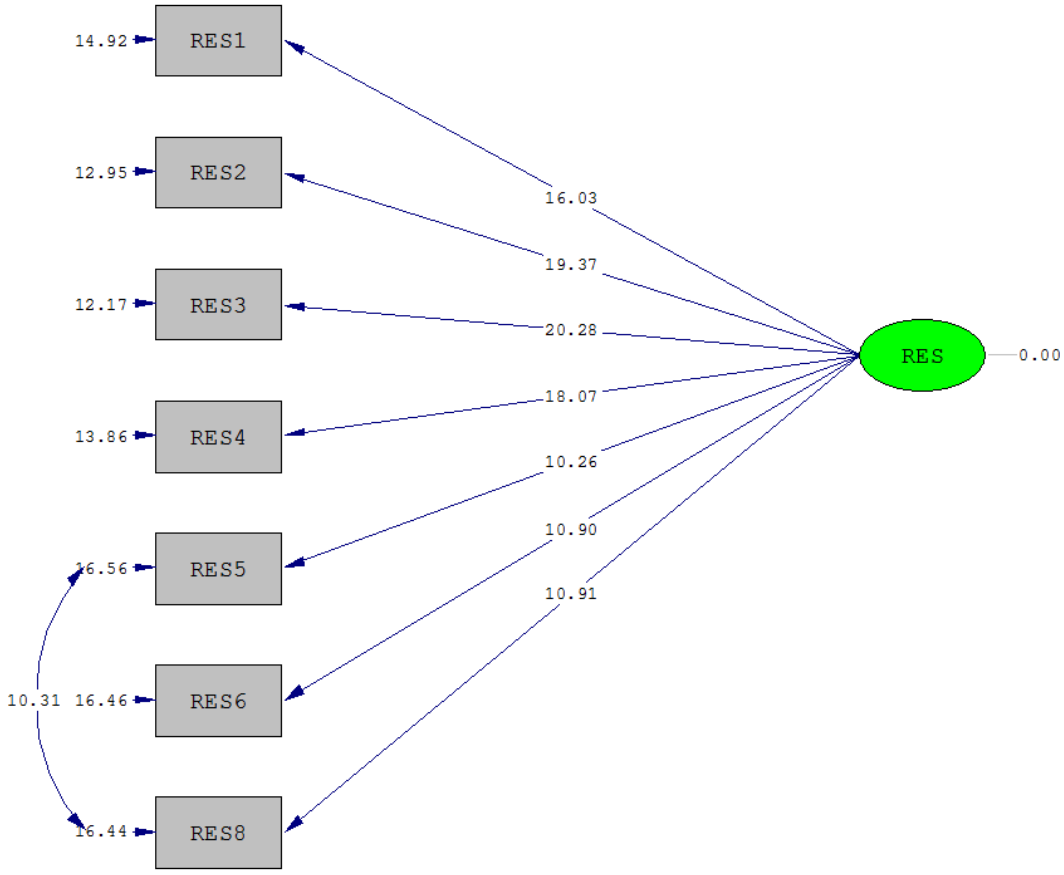

Figure 6. Path Diagram of One-Factor Academic Resilience in Mathematics Scale (after modifications)

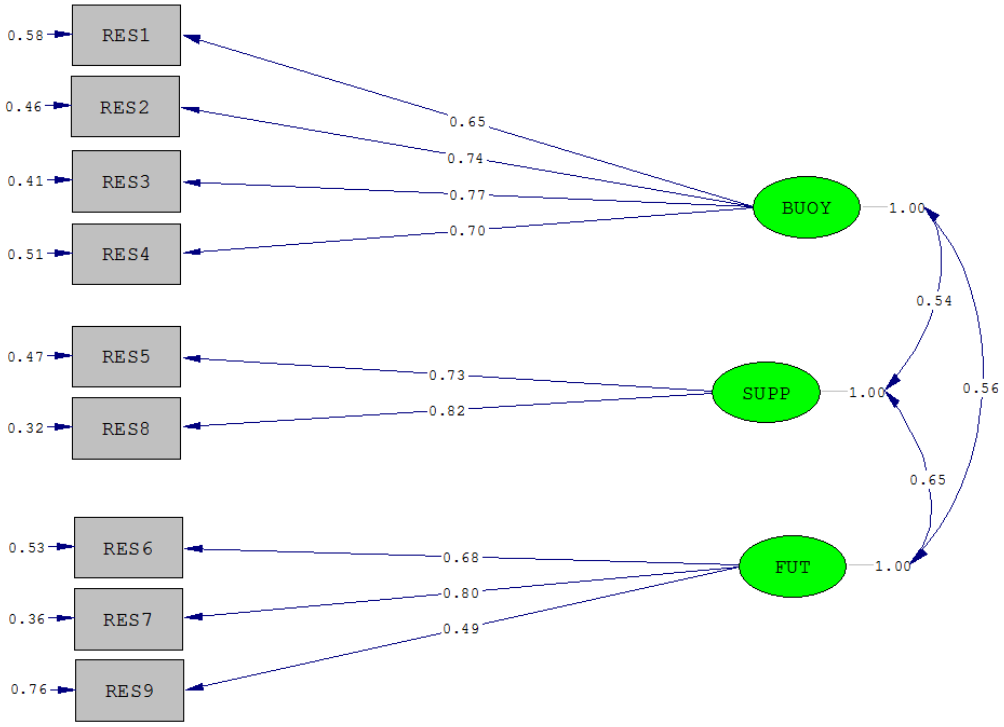

Figure 7. Path Diagram of Three-Factor Academic Resilience in Mathematics Scale

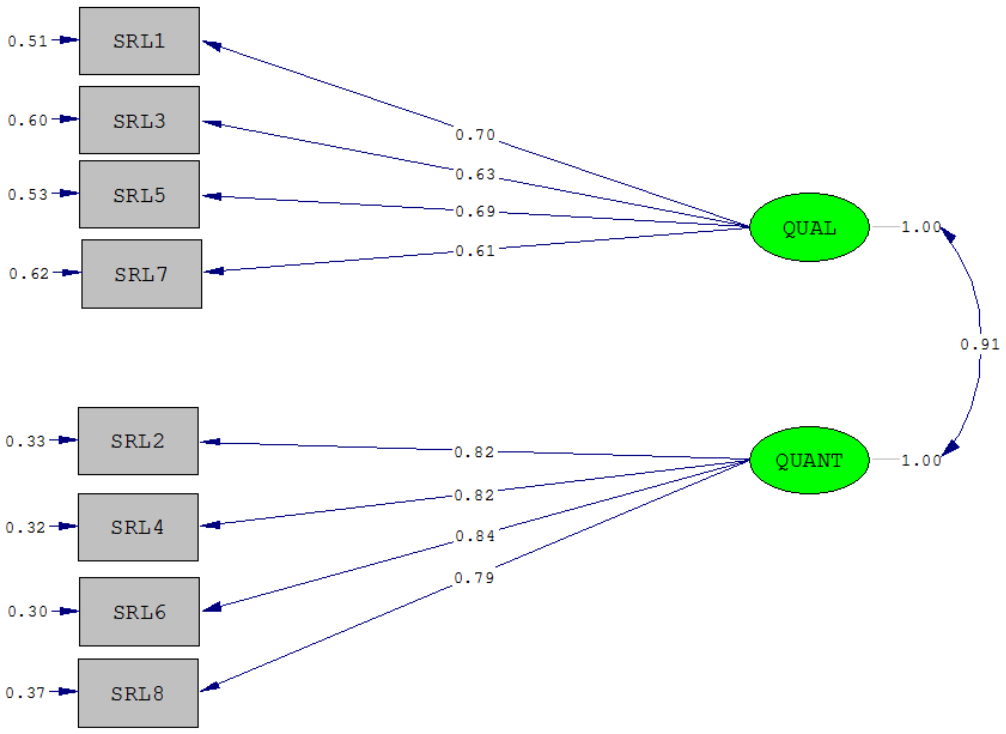

Figure 8. Path Diagram of Self-regulated Learning Scale

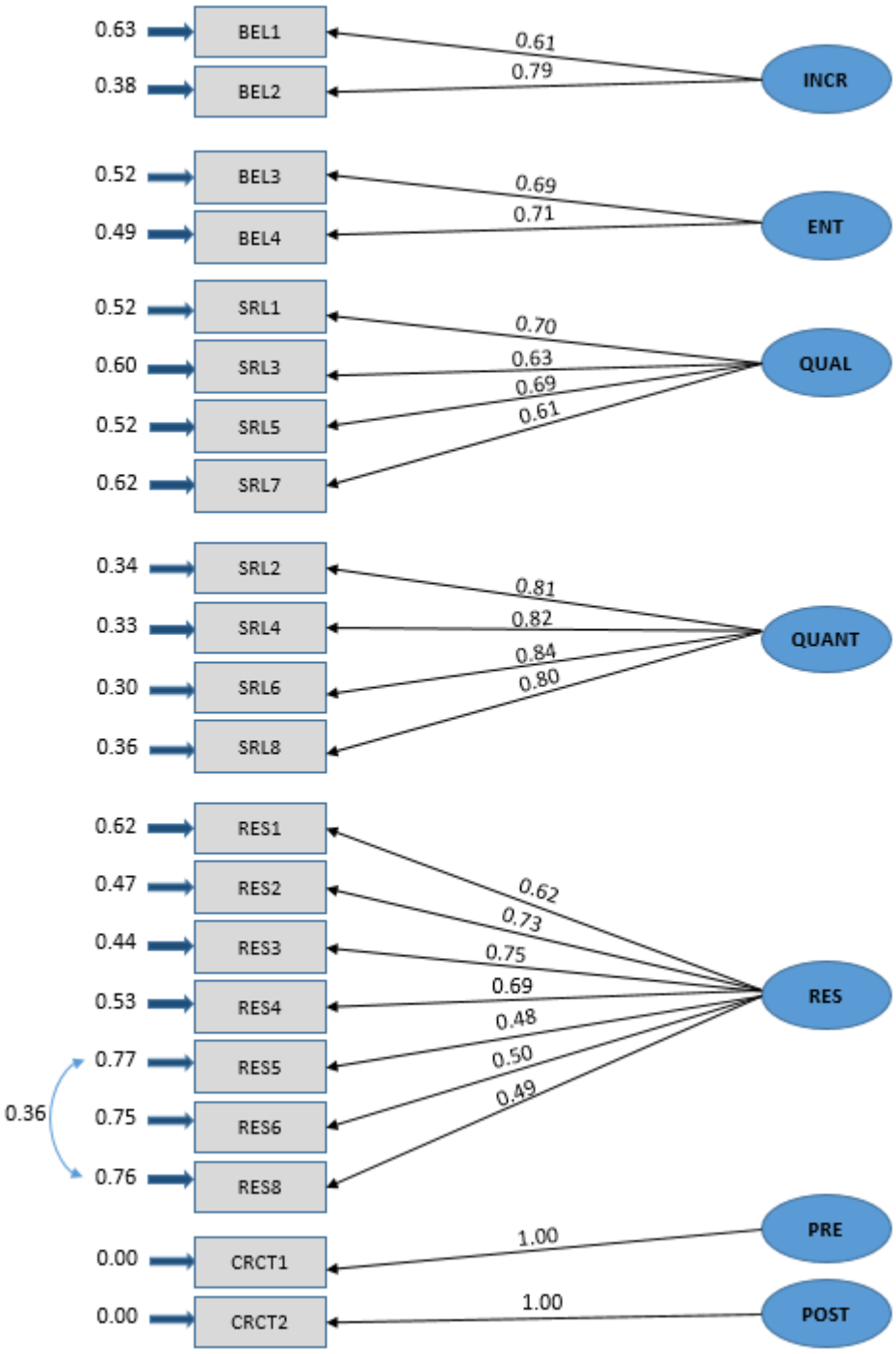

Figure 9. Full Measurement Model (with one-factor ARM scale)

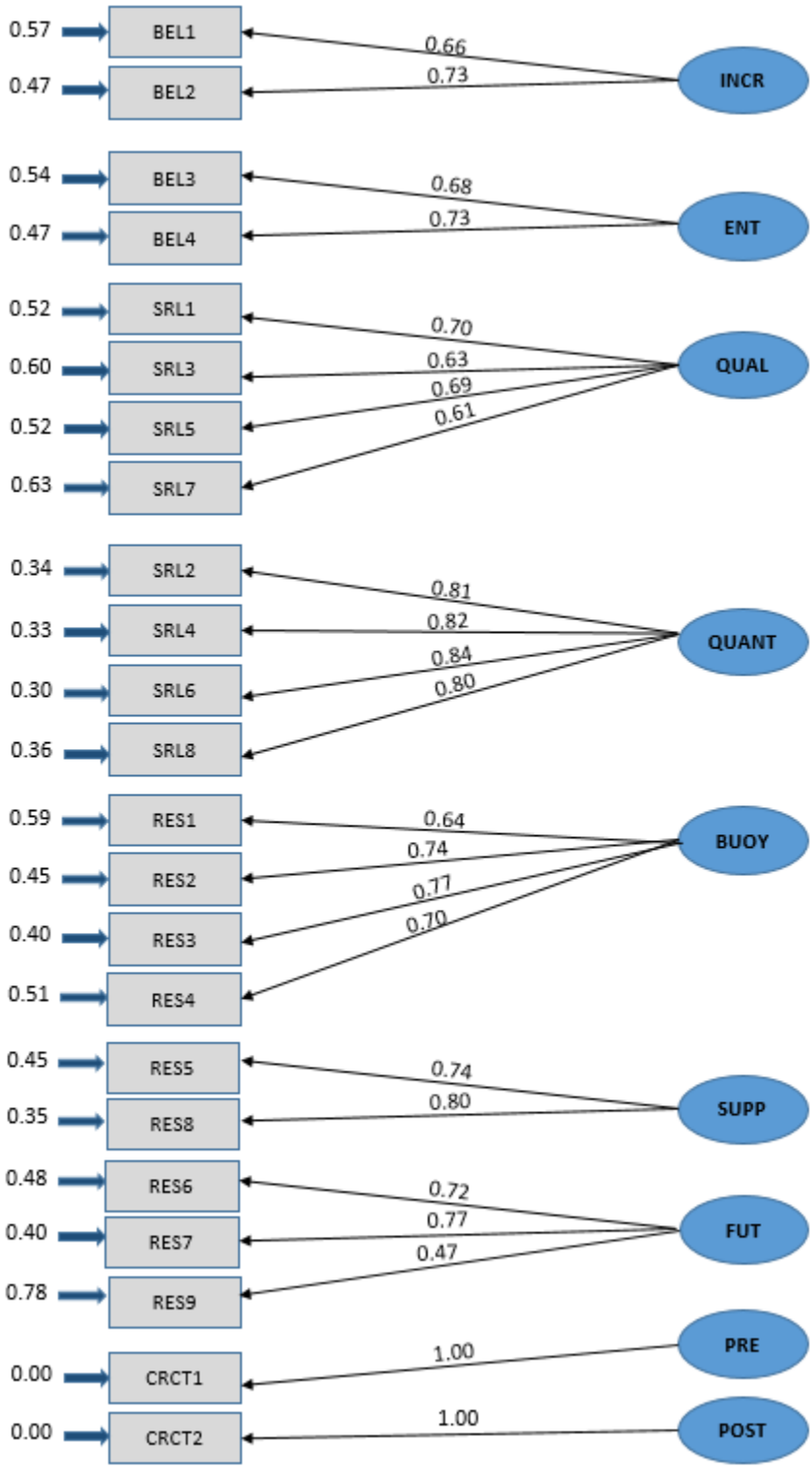

Figure 10. Full Measurement Model (with three-factor ARM scale)

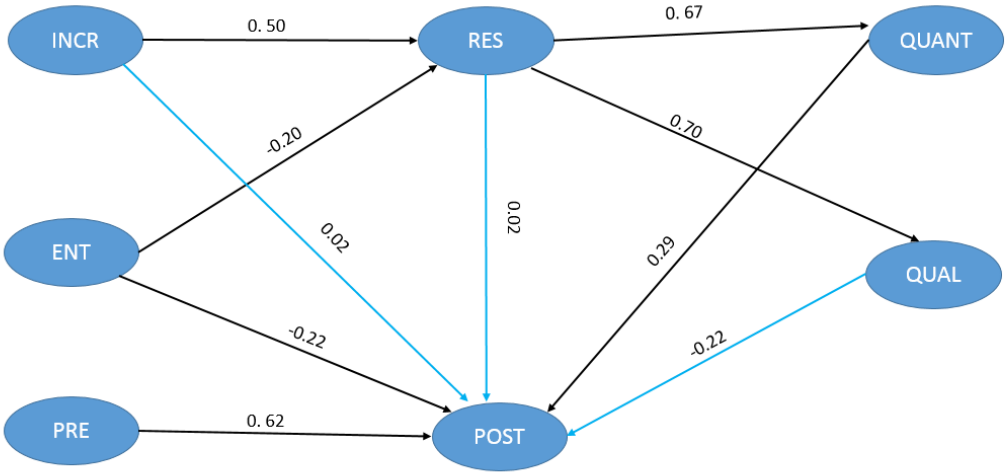

Figure 11. Structural Equation Model 1. Blue lines represent non-significant paths.

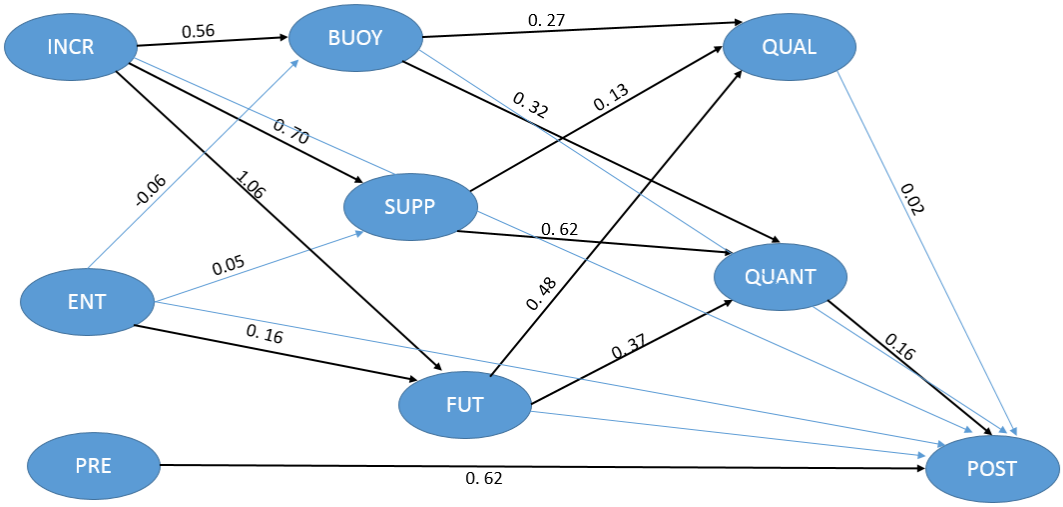

Figure 12. Structural Equation Model 2. Blue lines represent non-significant paths.

Appendix A.

Select Academic Resilience Studies (in chronological order)

Author(s)	Definition of Resilience	Operationalization of Resilience
Alva, S. A. (1991). Academic invulnerability among Mexican-American students: The importance of protective resources and appraisals. *Hispanic Journal of Behavioral Sciences, 13*, 18-34	"Academically invulnerable students can be described as those who sustain high levels of achievement motivation and performance, despite the presence of stressful events and conditions that place them at risk of doing poorly in school and, ultimately, dropping out of school" (p. 19)	Selected students were of Mexican heritage, currently in 10th grade, in the US since at least the 7th grade and not in Special Education programs. Academically invulnerable: students in top quartile based on Comprehensive Test of Basic Skills (CTBS) scores. Academically vulnerable: students in bottom quartile based on CTBS scores.
Finn, J. D., & Rock, D. A. (1997). Academic success among students at risk for school failure. *Journal of Applied Psychology, 82*, 221-234.	"successful adaptation to life tasks in the face of social disadvantage or highly adverse conditions" (p. 222)	African-American and Hispanic-origin. Surveyed at the end of 10th and 12th grades. Lower half of SES. Academically resilient: students who had passing grades throughout high school, scored 1/4th standard deviation below the mean of the entire population, graduated from high school on time Non-resilient completers: school completers with poorer academic performance Dropouts: Noncompleters
Waxman, H. C., & Huang, S. L. (1996). Motivation and learning environment differences between resilient and non-resilient inner-city middle school students. *Journal of Educational Research, 90*, 93-102.	"the heightened likelihood of success in school and other life accomplishments despite environmental adversities brought about by early traits, conditions, and experiences" (Wang, Haertel & Walberg, 1994, p. 46)	Inner-city middle school. Black and Hispanic students. Educationally resilient: scored at or above the 90th percentile on standardized mathematics achievement tests over a 2-year period. Non-resilient students: scored at or below the 10th percentile on standardized mathematics achievement tests over a 2-year period.

Morales, E. E., & Trotman, F. K. (2010). *A focus on hope: Fifty resilient students speak.* Lanham: University Press of America	"Academic resilience refers to the process and outcome of students who, despite coming from statistically "at-risk" backgrounds, *do* succeed academically" (p. 1)	Resilient students met the following two criteria: 1. Had parents with limited educational backgrounds who worked in low or semi-skilled jobs and self-identified as an ethnic minority. 2. at the time of the interviews had completed a minimum of 30 college credits and had a minimum GPA of 3.0
OECD (2011). Against the odds: Disadvantaged students who succeed in school, OECD Publishing.	"Resilient students come from disadvantaged backgrounds yet exhibit high levels of school success" (p. 22)	Resilient: Bottom 33% on measure of SES and of this group in top 33% on Program for International Student Assessment (PISA). Non-resilient: Bottom 33% on measure of SES and of this group in bottom 33% on PISA.

Appendix B.

Academic Resilience in Mathematics (ARM) Scale

Please rate the following statements on a scale from 1-6.
(1= Strongly Disagree; 2 = Disagree; 3 = Disagree somewhat; 4 = Agree somewhat; 5 = Agree; 6 = Strongly Agree)

1	I'm good at dealing with setbacks (e.g., bad mark, negative feedback on my work) in math	1	2	3	4	5	6
2	I don't let study stress get to me in math	1	2	3	4	5	6
3	I think I'm good at dealing with pressures in math	1	2	3	4	5	6
4	I don't let a bad math grade affect my confidence	1	2	3	4	5	6
5	I have someone to help me with math	1	2	3	4	5	6
6	I believe that math will be useful to me in the future	1	2	3	4	5	6
7	I believe that if I work hard at math, I can do well at it	1	2	3	4	5	6
8	I know where to get help if I'm having trouble with math	1	2	3	4	5	6
9	I plan to graduate from high school	1	2	3	4	5	6

Appendix C.

Implicit Theories of Intelligence Scale

1	I know I can get better in math if I try harder.	1	2	3	4	5	6
2	The more I learn, the better I will be in math.	1	2	3	4	5	6
3	I’m hopeless when it comes to math.	1	2	3	4	5	6
4	I will never get good grades in math.	1	2	3	4	5	6

Note. Items 1 and 2 measure an incremental view of intelligence; Items 3 and 4 measure an entity view of intelligence.

Appendix D.

Self-Regulated Learning Scale

1	When I do math, I check over my work.	1	2	3	4	5	6
2	Even when I don't want to work on math, I force myself to do the work.	1	2	3	4	5	6
3	When I do math, I ask myself questions to help me understand what to do.	1	2	3	4	5	6
4	Even when my math work is dull and uninteresting, I keep working until I finish.	1	2	3	4	5	6
5	When I make a mistake, I try to figure out where I went wrong.	1	2	3	4	5	6
6	I force myself to finish my math work even when there are other things I'd rather be doing.	1	2	3	4	5	6
7	Before I start a math problem, I read through all of the information to see how to organize it.	1	2	3	4	5	6
8	Even if I don't see the importance of a particular math assignment, I still complete it.	1	2	3	4	5	6

Appendix E.

IRB Determination Letter

EMORY UNIVERSITY | Institutional Review Board

TO: Mei-Lin Chang
Principal Investigator
Educational Studies

DATE: October 16, 2012

RE: **Continuing Review Expedited Approval**
CR1_IRB00051076

IRB00051076
The effects of cognitive and metacognitive strategy tutoring on the mathematical problem solving.

Thank you for submitting a renewal application for this protocol. The Emory IRB reviewed it by the expedited process on 10/3/2012, per 45 CFR 46.110, and/or 21 CFR 56.110. This reapproval is effective from **10/16/2012** through **10/15/2013**. Thereafter, continuation of human subjects research activities requires the submission of another renewal application, which must be reviewed and approved by the IRB prior to the expiration date noted above. Please note carefully the following items with respect to this reapproval:

The following items were approved during this renewal cycle:

- Coan College Student Assent Form (Vers. 9/18/2011)
- Coan Parent Consent Emory IRB 0913 (Vers. 9/18/2011)
- Coan StudentAssentForm 0913 (Vers. 9/18/2011)
- Chang Coan Protocol Emory IRB 0813 (Vers. 8/14/2011)

Any reportable events (e.g., unanticipated problems involving risk to subjects or others, noncompliance, breaches of confidentiality, HIPAA violations, protocol deviations) must be reported to the IRB according to our Policies & Procedures at www.irb.emory.edu, immediately, promptly, or periodically. Be sure to check the reporting guidance and contact us if you have questions. Terms and conditions of sponsors, if any, also apply to reporting.

Before implementing any change to this protocol (including but not limited to sample size, informed consent, study design, you must submit an amendment request and secure IRB approval.

In future correspondence about this matter, please refer to the IRB file ID, name of the Principal Investigator, and study title. Thank you.

Sincerely,

Aric Edwards
Research Protocol Analyst
This letter has been digitally signed

CC:	Hinnant	Brandi	Graduate Ed. Studies
	Ricketts	Shanna	Graduate A&S

Emory University
1599 Clifton Road, 5th Floor - Atlanta, Georgia 30322
Tel: 404.712.0720 - Fax: 404.727.1358 - Email: irb@emory.edu - Web: http://www.irb.emory.edu/