Self-Theories of Intelligence and Rural Middle School Students: Examining a Model of Achievement Motivation

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ABSTRACT

Psychosocial interventions to cultivate functional motivational beliefs in students are becoming increasingly popular. However, in education it is easy to prematurely place hope in promising, emerging techniques and ideas before they are fully explored through research. This study seeks to add to the body of knowledge examining psychosocial interventions by investigating one of the constructs popularly targeted in these interventions: self-theories of intelligence (STIs). Within this study, STIs are explored within a previously tested model of motivational variables (goal orientations, effort beliefs, interest, causal attributions, and failure response). The addition of metacognition to this model of achievement motivation is also investigated. Because research has suggested that STIs may be domain-specific, this study focused on STIs in the domain of science.

Within this study, I used a self-report instrument comprised of seven subscales (each representing one motivational variable) to collect information on the achievement motivation of rural middle school students in the domain of science. Students from three schools in two counties in rural southwest Virginia participated in the study (*n* = 367). Independent and paired-samples *t*-tests, confirmatory factor analysis, mediational analyses, and structural equation modeling were used to answer the following four research questions.

1. To what extent are rural middle school students' self-theories of intelligence fixed or malleable in the domain of science?
2. To what extent do rural middle schools students have metacognitive knowledge and skills in the domain of science?
3. Does metacognition mediate the relationship between a malleable belief of intelligence and positive effort beliefs?
4. To what extent does the Blackwell, Trzesniewski, and Dweck (2007) model fit data obtained from rural middle school students in the domain of science?

The results showed that the participants expressed a significant malleable view of intelligence, and demonstrated moderate amounts of metacognitive knowledge and skills. Metacognition was shown to be a significant mediator of STIs and effort beliefs. Standardized path coefficients for the achievement motivation model were significant; however, model fit indices revealed that this model may not be an adequate fit for these students' beliefs in the domain of science.

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Chapter 1: Introduction

Overview and Problem Statement

Arguably, one of the seminal functions of educational psychology is to build a sound bridge between theory and practice, allowing what is known about human learning to yield positive results for teachers and students alike. However, efforts to make the fruits of researchers' labors more accessible occasionally do not have the desired results. These undesired results can include wasted time and resources on educational techniques, practices, or interventions that do not provide the anticipated results. Previous instances of enthusiasm overstepping what is known about a concept can easily be found in education, where limited time and resources intensifies the allure of the quick fix or the "silver bullet" (Watson, 2012). This allure is understandable. Well-intentioned educators continually look for ways to help students succeed, especially those who are disadvantaged by race, gender, or socioeconomic status. This desire can lead educators to seek out new and inventive ways to engage students and help them achieve. It can also lead educators to put their hopes in practices that are not fully vetted.

In avoiding these undesired results, it becomes even more important that concepts, programs, and interventions that are conceived within the realm of research be allowed to mature before they packaged for broader consumption in the realm of practice, and this maturity is achieved when the validity of the theoretical foundations and instrumentation of a concept or program are properly demonstrated (Messick, 1995). This legwork requires time and attention to theoretical and methodological detail on the part of educational researchers. When researchers uncover a concept or idea that shows a surprising amount of promise in solving an educational issue, it is crucial to gain a proper understanding of the contribution this concept can truly make.

Self-theory of intelligence (STI), one educational concept that is still in the infancy of validation, has shown some surprising potential in addressing the systematically lower levels of academic outcomes for minority status and low-income students, as well as female students in the domains of science and math. Several studies suggest that having one particular self-theory of intelligence, the theory that intelligence is changeable or *malleable*, can reduce the effects of stereotype threat and protect students from the usual dip in grades during the middle school transition. It has been suggested that STIs operate within a network of motivational variables to ultimately impact achievement (Blackwell, Trzesniewski, & Dweck, 2007; Dweck & Molden, 2005). Based on previous studies, researchers have suggested that a malleable view of intelligence may encourage students to adopt a mastery goal orientation, view effort as a vehicle through which they can improve their learning outcomes, and try again after failure. Students who believe that intelligence can be improved may be more likely to approach learning tasks as opportunities to expand their knowledge and expertise, with less focus on demonstrating the knowledge they already have (Dweck & Molden, 2005). Malleable-view students may also be less likely to view failure as an indication that they are not smart enough or are not capable of completing the task. They are also more likely to increase their effort on a task after failure (Dweck & Molden, 2005). Previous evidence suggests that these tendencies may lead malleable-view students to higher levels of achievement and improved learning outcomes, regardless of gender, race, or socioeconomic status (Aronson, Fried, & Good, 2002; Dweck & Leggett, 1988; Hong, Chiu, Dweck, Lin, & Wan, 1999).

One possible connection that has been suggested by previous research, and yet largely unexplored thus far, is that between STIs and metacognition (Abdullah, 2008; Jones, Slate, Marini, & DeWater, 1993; Ommundsen, Haugen, & Lund, 2005). Research thus far has demonstrated that a malleable view of intelligence may lead to increase self-regulatory behaviors in students. It is possible that a malleable view of intelligence may lead to increased metacognitive abilities overall, and these metacognitive abilities have been linked to increased achievement (Zulkiply, Kabit, & Ghani, 2008). Investigating this possible connection is a necessary step in fully understanding STIs as a concept.

A handful of intervention studies based upon this achievement motivation model have successfully encouraged students to adopt a malleable STI and have demonstrated positive outcomes in student achievement over time. However, this model of achievement motivation has only been tested twice (Blackwell et al., 2008, Jones, Wilkins, Long, & Wang, 2011), and further research is needed to continue to assess the strength of this model in predicting achievement motivation. Because STI research has demonstrated the possible impact of this concept, and interventions to encourage a malleable self-theory are currently being developed and implemented, the relevance and validity of this concept deserves further examination. Without a better understanding of the processes involved in this model, researchers and educational practitioners might waste money and resources by developing and implementing interventions that have little to no impact. They may also wrongly discard STIs and STI-focused interventions as a possible solution without strong empirical support.

Purpose

The purpose of this dissertation is to contribute to the maturation of STIs as a construct. This will be achieved by performing some of the theoretical and methodological legwork necessary in order to gain a more complete understanding of the impact of STIs on students' achievement motivation. To maintain consistency with previous research, STIs will be explored within the framework of a motivational model that has been tested twice (Blackwell et al., 2007;

Jones et al., 2011). I intend to examine the theoretical foundations for this model within the literature while also testing the fit of this model within a new population (rural middle school students) and domain (science). The specific purposes of this investigation are three-fold: first, to review the literature on the development and measurement of STIs as well as correlations to other motivational variables; second, to explicate the possible connection between STIs and metacognition and its possible benefits for low-income and middle school students; and finally, to address gaps in the research by further investigating the soundness of the model and the STI-metacognition connection in the domain of science.

Outline of the Dissertation

This dissertation includes five chapters. The current chapter presents the problem that is to be addressed through this dissertation and the overall approach in addressing this problem. Chapter Two is an in-depth review of the literature in order to establish the necessary theoretical foundations for this study. This discussion occurs in four parts, and will begin with an exploration of the relationship of STIs to seven other motivational variables (goal orientations, effort beliefs, causal attributions, positive learning strategies, self-esteem, behavioral response after failure, and achievement). Previous research testing the model of achievement motivation currently under consideration will be discussed, as well as what is currently known about the development of STIs. The measurement of STIs will also be discussed. Second, metacognition as a construct will be explored and operationally defined. Current methods for measuring metacognition will be discussed. In the third section, the possible relationship between STIs and metacognition will be discussed, as well as its relevance for addressing current educational issues. The fourth and final section will identify and describe the future research necessary to gain a complete understanding of STIs, this model of motivation, and STIs' relevance in improving academic outcomes for students.

After laying the groundwork for this study through this discussion of relevant theory, Chapter Three discusses the overall design and methodological approach for this study. Research questions will be presented and the purpose of the study will be readdressed. A demographical description of the participants for this study is included, as well as the rationale for choosing these participants. Detailed descriptions will be given for the measures used in this study, as well as the procedure used for data collection and the various analyses. Within Chapter Four, the results of the data analyses are presented, with preliminary and brief interpretations. In-depth discussion of the meanings of the results takes place in Chapter Five, and these meanings are contextualized within the initial research questions. Chapter Five also includes a discussion of limitations of the research and conclusions for the current study.

According to Boote and Beile (2005), it is important for graduate students to discuss and justify the exclusion or inclusion of literature within a literature review. I located sources for this research mainly by using references from peer-reviewed journal articles that had made significant contributions to the literature or that were heavily cited by other authors. I also located sources searching the ERIC database. The literature on STIs and the achievement motivation model is still fairly new; therefore, there are not as many sources from which to choose when constructing a literature review. For this reason, I included some sources in this section that may have been excluded if the body of literature had been more robust. The literature on metacognition is much richer than the literature on STIs. I included sources in the metacognition section if they represented a pivotal point in the development of the construct, or if they provided information on the most recent state of the construct.

Chapter 2: Background

The current section will build the theoretical foundation of this study in five parts. The first section will discuss the current state of the research on STIs as an independent construct and within the achievement motivation model, as well as the most commonly used instrumentation for this concept. This discussion will also address current weaknesses in the research. The second section will discuss metacognition, its impact on learning, and measurement. Within the third section, the theoretical and empirical support for the STI-metacognition connection will be explored, and the justifications for investigated this connection will be discussed. The fourth section lays out the research that is yet to be conducted and is necessary to understand the impact of STIs and this model. This section suggests the necessary next steps in the research, and situates this study within those steps. The fifth and final section discusses the purpose and research questions that will guide the study.

Self-Theories of Intelligence

Every individual has a personal conception of what intelligence is, or a *self-theory of intelligence* (STI). These personal conceptions can be divided into two categories: a malleable/incremental belief and a fixed/entity belief (Dweck & Leggett, 1988). Within the research, the terms *malleable* and *incremental* have been used to describe the same belief. The terms *fixed* and *incremental* have also been used interchangeably. For the purposes of this study, the term *malleable* will be used to describe a belief that intelligence is something that can be improved over time through effort and learning. A *fixed* belief describes the view that intelligence is something that individuals are born with and level of intelligence is seen as static and outside of the individual's control. Research suggests that these two different beliefs go on to impact students' behaviors before, during, and after a learning task: those with a malleable view are more likely to exert more effort before and during a task, and are more likely to try again after failure (Dweck & Molden, 2005). Beliefs about intelligence also go on to impact various other conceptions held by the learner, such as learning goals, effort beliefs, attributions, and self-esteem (Dweck & Molden, 2005). By impacting these behavioral and cognitive factors, STIs also impact students' academic performance. These effects have been demonstrated in a number of studies, some of which will be discussed in this paper. Fully understanding the relationship of STIs to these variables is necessary in assessing STIs' impact on students' academic outcomes.

Some researchers have begun the work of investigating the relationship between STIs and epistemological beliefs (Braten & Stromso, 2004, 2006; Hofer & Pintrich, 1997; Schommer, 1990; Schommer, Crouse, & Rhodes, 1992). Epistemological beliefs, or beliefs about the nature of knowledge, consist of four core components, according to Hofer & Pintrich (1997). Individuals hold beliefs concerning the *source of knowledge*, wherein they tend to believe either that knowledge originates from external, expert sources (the naïve conception), or they believe that they are the meaning-makers and are active participants in the development of knowledge (the sophisticated conception). Second, individuals hold beliefs about the si*mplicity of knowledge*. Here, individuals tend to conceive of knowledge as concrete, isolated facts (naïve conception), or as contextual and interrelated (sophisticated view). Third, there are also beliefs about the *certainty of knowledge*, or whether the individual views knowledge as fixed and static (naïve conception) or fluid and changeable (sophisticated conception). Finally, epistemological beliefs also involve beliefs about the *justification of knowing*, which concerns the process individuals go through in evaluating claims and how much weight they give to the opinions of figures of authority (Chen & Pajares, 2010; Hofer & Pintrich, 1997). When investigating the relationship of epistemological beliefs and preservice teachers, Fives and Buehl (2008) found that teachers with a fixed view of intelligence were more likely to pursue knowledge of the logistics of teaching, and how to streamline the teaching process. Teachers with malleable views were more likely to value understanding the theoretical foundations of teaching practices. Chen (2011) found that, for two groups of students with sophisticated epistemological beliefs, those with a malleable view of intelligence exhibited higher self-efficacy and self-concept, more adaptive beliefs about self-regulation, and a stronger mastery goal orientation. With this evidence in mind, Hofer and Pintrich (1997) have argued for the separation of beliefs about knowledge and beliefs about ability so as to avoid confusion between the two ideas. Chen (2011) compared this conceptualization of the relationship between epistemological beliefs and STIs to Schommer-Aikens' (2004) conceptualization of an Embedded Systemic Model. Within this model, these two constructs remain distinct, but their interrelatedness is recognized (Schommer-Aikens, 2004). Overall, the research suggests that students' epistemological beliefs are related to their self-theories of intelligence, but are a distinct construct. This relationship requires further investigation in order to gain a more complete understanding.

With regard to the development of the construct of STIs, in the initial research on self-theories, STIs were not the focus of the discussion, nor were they directly related to the classroom experience. Instead, researchers focused on the connection between self-theories of intelligence and coping strategies (Dweck, Chiu, & Hong, 1995; Hong et al., 1999). Over time, research showed that STIs were related to other motivational variables and that these relationships, in turn, impacted academic outcomes. Eventually, Dweck and her colleagues proposed a model that related STIs to several other constructs, and illustrated the possible importance of STIs in education (Dweck & Molden, 2005).

The following sections begin with an in-depth discussion of the research investigating the relationships between STIs and seven other motivational variables. Strengths and weaknesses of Dweck and Molden's (2005) proposed model will be discussed, as well as previous research statistically investigating a variant of this model (Blackwell et al., 2007; Jones et al., 2011). Finally, issues in measurement will be discussed with regard to the various constructs in Blackwell et al.'s (2007) version of the model, with a more detailed look at issues in the measurement of STIs.

Dweck's model: STIs as part of a motivational framework. Dweck and her colleagues propose that students' STIs, whether malleable or fixed, will interact with other motivational variables and ultimately impact their achievement or academic performance (Dweck & Leggett, 1988; Hong et al., 1999). Self-theories of intelligence and seven other constructs work within a system of meaning to create different outcomes for students These include goal orientation, effort beliefs, causal attributions, learning strategy choice and use, behavioral response after failure, self-esteem, and achievement (Dweck & Molden, 2005; see Figure 1). The following sections will detail the relationship of STIs to each of these constructs.

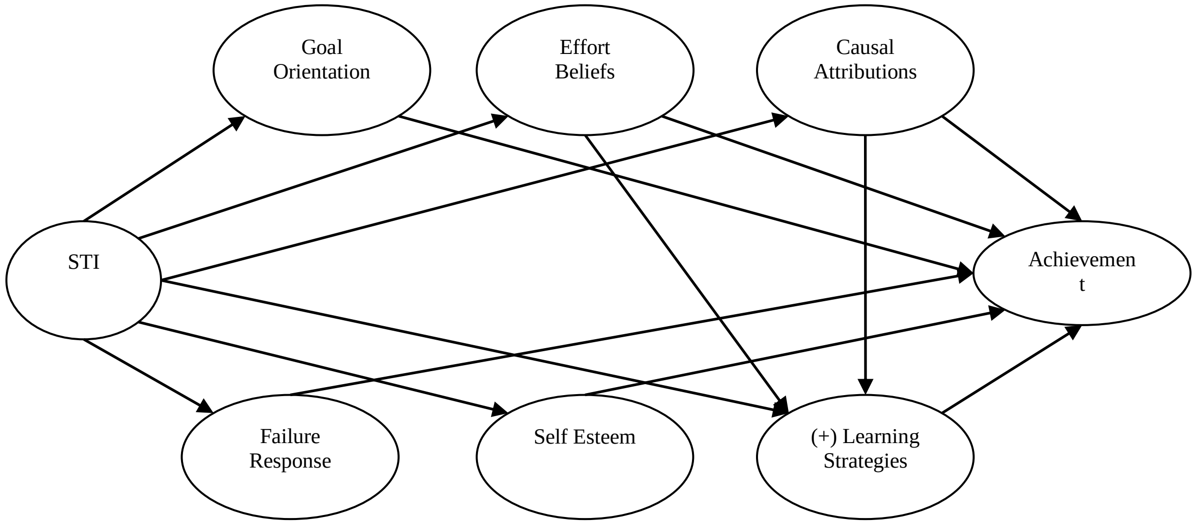

Figure 1. Theoretical model of the relationship of STIs to the seven motivational variables, compiled from Blackwell et al. (2007) and Dweck and Molden (2005).

Goal orientation. Goal orientations are the viewpoints from which individuals approach a learning task. According to the commonly employed model of goal orientation, there are three categories of these viewpoints: mastery goal orientation, performance-approach goal orientation, and performance-avoid goal orientation (Elliot & Dweck, 1988; Elliot & Harackiewicz, 1996). Students adopting a mastery goal orientation approach learning tasks with the intent of mastering the material and achieving a deeper level of knowledge. Students with a performance-approach goal orientation approach learning tasks as an opportunity to demonstrate their ability. Finally, students adopting a performance-avoid goal orientation approach learning tasks with the intent of avoiding demonstrating a deficiency in ability. Research has shown that a mastery goal orientation and a performance-approach goal orientation can be beneficial to the student, leading them to deeper levels of knowledge and higher achievement (Meece, Anderman, & Anderman, 2006). A performance-avoid goal orientation can be detrimental to the student; possibly because the accompanying performance anxiety can overwhelm students' working memory and hinder academic performance (Meece et al., 2006).

According to Dweck and Molden's (2005) proposed model, an individual's STI will affect her or his goal orientation. In other words, students with a malleable view of intelligence will approach learning tasks from the view that such tasks are an opportunity for them to increase their knowledge and ability. They argue that these students are more likely to adopt a mastery goal orientation, where they view the learning task as an end in itself, and will work to understand the problem and its solution fully. Students with a fixed view of intelligence are more likely to adopt performance-approach or performance-avoid goal orientations. These students will view a learning task not as an opportunity to increase their ability, but as an opportunity to display their ability or avoid displaying their deficiencies. This distracts them from the process of the learning task and focuses them solely on finding "the right answer," instead appreciating the subtleties of the problem (Dweck & Molden, 2005).

The relationship between STIs and goal orientation has been investigated by a number of studies wherein the researchers used participants from a variety of backgrounds and life experiences. The findings can be difficult to interpret. In one study of American undergraduate students, the researchers found that a fixed belief of intelligence related positively to a performance goal orientation, but did not find that a malleable belief was positively related to a mastery/learning goal orientation (Roedel & Schraw, 1995). These findings lend partial support to Dweck's model; however, it should be noted that the researchers did not differentiate between performance-approach and performance-avoid goal orientations, instead grouping these two constructs together. This makes it impossible to determine whether students with a fixed belief tend to view learning tasks as opportunity to display their ability or hide their inability. In a more recent study, once again using American undergraduate students, goal orientations were again divided into two constructs: performance goal orientation and mastery goal orientation (Robins & Pals, 2002). These researchers found a strong relationship between a fixed belief and performance goal orientation and between a malleable belief and mastery goal orientation. It is unclear why this difference would exist; both studies use similar measures of STI's and goal orientations. In a later study of American middle school students, researchers' results supported the Robins and Pals (2002) study, finding a strong positive relationship between a malleable belief and a mastery goal orientation (Blackwell et al., 2007). In a study of Greek elementary students, researchers took into account the difference between performance-approach and performance-avoid goal orientations (Leondari & Gialamas, 2002). They found that a malleable belief of intelligence related positively to both a mastery and performance-approach goal orientation, and negatively to a performance-avoid orientation (Leondari & Gialamas, 2002).

Whereas the researchers in these studies all found slightly different results, none of these outcomes are necessarily contradictory. These findings taken as a whole suggest two important things about the relationship between STIs and goal orientations: first, that a malleable belief of intelligence makes a student less prone to adopting a performance-avoid goal orientation; and second, that a fixed view of intelligence makes a student less likely to adopt a mastery goal orientation. It is possible that a malleable view of intelligence makes a student more likely to adopt a mastery goal orientation or a performance-approach goal orientation, both of which can be functional during a learning task (Meece et al., 2006).

Effort beliefs. Effort beliefs are the values that individuals attach to any effort exerted during a learning task. Students with positive effort beliefs believe that effort is a way to improve ability, while students with negative effort beliefs would view effort as an inverse correlate of their ability level. These beliefs affect the learning and study behaviors of the individual, which in turn affect achievement outcomes (Dweck & Molden, 2005). According to Dweck's model, these beliefs also relate to an individual's self-theory of intelligence (Dweck & Molden, 2005). Students with a malleable belief will view effort as a way to increase their intelligence, and will increase their effort during a learning task. Students with a fixed belief will think that they should need only minimal effort to complete a task; this causes them to avoid exerting more effort as this would cause them to question whether their intelligence was sufficient. This belief that effort is a sign of deficiency can cause students to avoid or give up on challenging tasks, and can lead to negative affect after failure (Hong et al., 1999; Dweck & Leggett, 1988).

This particular trend in Dweck's model has been strongly supported by the research. Researchers found that, for a group of undergraduate students, those with a fixed view of intelligence chose weaker study strategies that required less effort than their malleable belief counterparts (Jones et al., 1993). Students with a malleable view were more likely to complete assignments ahead of time and use strategies that involved processing the material. Fixed belief students were more likely to rely on rote memorization (Jones et al., 1993). In a more recent study, researchers found the same trend to be true for middle school students (Blackwell et al., 2007). For seventh-graders, results showed that a malleable belief about intelligence was related to positive beliefs about effort: these students were more likely to think that working hard at something made you better at it (Blackwell et al., 2007). This relationship then went on to affect students' grades. Students with positive effort beliefs showed higher grades than those with negative effort beliefs (Blackwell et al., 2007). Stipek and Gralinski (1996) also found that students with a fixed view of intelligence expressed negative effort beliefs. The findings from these studies show that a malleable view can lead students to value working hard to accomplish a learning task. A fixed view can lead students to believe that having to work hard indicates deficient ability.

Causal attributions. Causal attributions are the reasons students give for their successes and failures. These reasons (or attributions) have three dimensions: locus, stability, and controllability (Wiener, 2005). After an outcome, students can attribute success or failure to a locus that is either internal to themselves, such as ability, or external, such as illness or a poor teacher. These attributions can also account for whether factors affecting the outcome were stable, such as long-term effort, or unstable, such as luck or chance. Finally, these attributions also contain information on how much control the student perceived he or she had over the outcome. Causal attributions are an integral part of the model. Arguably, a student with a fixed belief of intelligence is more likely to make an internal attribution that is stable and uncontrollable: a fixed level of aptitude (Dweck & Molden, 2005). A student with a malleable view of intelligence will be more likely to make an internal attribution that is controllable, since ability is viewed as something the student can impact and change. This student is more likely to take remedial action and try again after failure (Hong et al., 1999).

In a study of a diverse group of 508 undergraduates (with regard to ethnicity and socioeconomic status), researchers investigated the relationship between STIs and attributions (Robins & Pals, 2002). Students with a fixed conception tended to make uncontrollable attributions for both successes and failures. For failure in particular, these students also attributed outcomes to their fixed level of ability (Robins & Pals, 2002). Malleable belief students were more likely to attribute success and failure to effort exerted and study skills used (Robins & Pals, 2002). The researchers also found that fixed belief students were prone to experiencing shame regarding their academic performance, whereas malleable belief students were more likely to feel determined and inspired (Robins & Pals, 2002). This difference occurred despite the fact that researchers found no significant difference in grades for the two groups (Robins & Pals, 2002). This study supports earlier findings where, when given negative feedback, malleable belief students were more inclined than fixed belief students to attribute their failure to effort (Hong et al., 1999). Hong et al.'s (1999) study also involved undergraduate students, and found that even highly confident students with fixed beliefs were still more likely to attribute failure to a fixed level of ability instead of effort. In a more recent study, researchers found that a malleable belief of intelligence predicted fewer helpless attributions: students with a malleable belief were less likely to believe that they were helpless to impact or change their level of performance (Blackwell et al., 2007). These students were also more likely to choose positive strategies and evaded the dip in grades typically associated with the transition to middle school (Blackwell et al., 2007). Overall, research has shown that a malleable conception of intelligence may make students feel empowered when it comes to their academic performance, whereas a fixed view may make students feel helpless.

Positive learning strategies. Self-theories of intelligence have also been shown to predict the learning strategies that students make use of before and after a learning outcome. In preparation for a learning task, students can choose to make use of strategies that focus on learning and processing of material, or they can choose strategies that focus on rote learning and memorization. When this is applied to Dweck and Molden's (2005) model, a malleable conception of intelligence predicts the use of more effective learning strategies, whereas a fixed conception predicts the use of rote learning and memorization. After negative feedback, a student with a malleable conception is more likely to try harder on the next task than a student with a fixed conception. Students with a fixed conception are more likely to express that they would spend less time on a specific subject after failure, since this failure is seen as an indicator of deficient abilities (Dweck & Molden, 2005).

A 1993 study of undergraduate students supports Dweck's model. The researchers compared malleable view students to fixed view students with regard to study skills and strategies (Jones et al., 1993). The malleable view students used strategies that focused on deeper levels of learning; fixed view students were more likely to use rote learning study skills (Jones et al., 1993). In a study of pre-service teachers, researchers found that a malleable view of intelligence correlated with higher self-regulatory skills and strategies that involved deeper processing of information (Ommundsen et al., 2005). These results have been found with younger participants, as well. For a group of children age 10 to 12 years old, researchers found that malleable beliefs predicted self-regulated learning behavior (Abdullah, 2008). That is, students who held the belief that intelligence could be enhanced were more likely to make use of learning strategies (Abdullah, 2008). These studies show that a malleable STI leads students to make more positive choices in terms of their learning strategies, and this choice can impact students' performance in the classroom.

Self-esteem. The construct of self-esteem also plays a role within Dweck and Molden's (2005) model. Students' self-esteem, or feelings of self-worth, can increase or decrease as a result of academic outcomes (Dweck & Molden, 2005; Niiya, Crocker, & Bartmess, 2004). Successes and failures can both affect students' self-esteem, but the nature of that impact may be mediated by STIs (Niiya et al., 2004; Robins & Pals, 2002). Dweck and her colleagues contend that STIs may make some students' self-esteem more vulnerable while making others' more resilient (Dweck & Molden, 2005). Niiya et al. (2004) found that, when they primed undergraduate students to have a fixed conception of intelligence, these students experienced lower self-esteem after failure than they did after success. Students who were primed to have malleable views did not experience this negative impact on their self-esteem after failure; in fact their self-esteem remained the same as it did following success (Niiya et al., 2004). A study by Robins and Pals (2002) showed the long-term effects of STIs on self-esteem. Their study followed undergraduate students throughout their college careers, and found that students with a malleable view of intelligence experienced an increase in self-esteem throughout college, while students with a fixed view experienced a decrease (Robins & Pals, 2002). Both of these studies illustrate the fact that a malleable view of intelligence may buffer students' self-esteem after they experience failure.

Behavioral response after failure. One of the most important aspects of Dweck's model is the relationship between an individual's conceptions of intelligence and their behavioral responses after failure. When a student experiences failure, they can either choose to take action to improve their performance in that subject area, or they can choose to devalue the subject and invest less time on the material. According to Dweck and her colleagues, a student with a malleable view will choose to take remedial action; a student with a fixed view will see remedial action as pointless since they are powerless to improve their performance (Dweck & Molden, 2005). A study published in 1999 tested this relationship. Researchers hypothesized that, of a group of university freshmen in Hong Kong, those with a malleable view of intelligence would be more likely to choose remedial action after a failure. The results showed that students with a malleable view were more likely to take a remedial English class after receiving a C or lower on their last English exam than students with a fixed view (Hong et al., 1999). Interestingly, students with a fixed view who scored an A or a B on their last English exam were just as likely to take a remedial English course as malleable view students who scored poorly (Hong et al., 1999). This is most likely because taking the English course would confirm their ability – they had no need to worry about confirming a deficiency since they had already performed well in English. The researchers point out that, in Hong Kong, a high level of English ability is necessary to be successful in the university setting; yet fixed view students were still avoiding a remedial English course (Hong et al., 1999). This suggests that students with a fixed view will avoid taking action to improve skills that they know they must have to succeed, which will eventually go on to impact achievement.

Achievement. The final piece in Dweck's model is achievement. Achievement can refer to a student's grade point average or to their performance on a learning task. The relationship of STIs to achievement is a complicated one. Research results are inconclusive as to whether or not a direct link between STIs and achievement exists (Blackwell et al., 2007; Gonida, Kiosseoglou, & Leondari, 2006). Although some researchers have found a direct link between a fixed view of intelligence and lower achievement levels (Stipek & Gralinski, 1996), Dweck and her colleagues argue that STIs may have an indirect link to achievement, mediated by learning goals, effort beliefs, learning strategies, and attributions (Dweck & Molden, 2005). For example, students with a malleable view of intelligence will be more likely to adopt a mastery goal orientation, which will lead them to exert more effort towards a learning task. These students will also believe that effort is a mechanism to enhance intelligence and therefore use learning strategies that require more effort, and then attribute their success or failure to the level of effort or the types of strategies they used to complete the task. Because success and failure are attributed to effort and strategies, these students will be more likely to try again after failure. All of these factors lead the student to obtain higher grades and perform better than students with a fixed belief (see Figure 1).

Blackwell et al.'s (2007) study followed a group of 373 seventh-grade students throughout their middle school careers. The researchers found that the students who expressed a fixed view of intelligence experienced a drop in grades over a two-year period, which is normal for students transitioning into middle school (Blackwell et al., 2007). However, the students that expressed a malleable view of intelligence escaped this drop in grades (Blackwell et al., 2007). There was a significant difference between the fixed view students' grades and the malleable view students' grades at the end of the study (Blackwell et al., 2007).

In two other studies, researchers found an interesting twist on the relationship between STIs and achievement (Gonida et al., 2006; Jones et al., 2011). To determine the directionality of the relationship between STIs and achievement, three causal models were tested. Instead of finding that STIs impacted student achievement, the researchers found that level of achievement impacted a student's beliefs about intelligence – students with a higher level of achievement were more likely to adopt a malleable view of intelligence (Gonida et al., 2006). Using structural equation modeling, Jones et al. (2011) obtained results demonstrating that students' grades impacted their beliefs about intelligence. When the results from all four of these studies are considered, it suggests that the relationship between students' beliefs and achievement may be cyclical. A student may adopt a malleable view of intelligence, which may cause them to make decisions that result in higher grades. These higher grades would then reinforce the student's belief that they can impact their level of ability, which will once again lead them to make more constructive choices.

All of the constructs mentioned in this section – goal orientations, effort beliefs, attributions, learning strategies, self-esteem, behavioral response after failure, and achievement – interact with an individual's conception of intelligence to create a motivational network of meaning (Dweck & Molden, 2005). Each of these constructs impact each other and ultimately achievement in unique ways. To understand the importance of self-theories, one must understand the relationships between STIs and these other constructs.

Strengths and weaknesses of Dweck's model. The strength of Dweck's model comes from two factors: first, Dweck and her colleagues do not attempt to define intelligence; and second, within the model, STIs are situated among a host of other variables. When reading the work of Dweck and her colleagues, one cannot help but notice what at first appears to be a glaring omission: they make no attempt to define intelligence. It would seem necessary to define intelligence if there is going to be a discourse on students' beliefs about intelligence, but this may not be the case. Although the construct is termed "self-theories of intelligence," researchers investigating STIs having little interest in pinning down the subtleties of each individual's unique definition. What is more important is how certain aspects of each individual's beliefs go on to impact behavior. Dweck's model suggests that it is less imperative to determine whether an individual believes intelligence to be someone with a good memory or more declarative knowledge, but instead, whether the student believes he or she can impact his or her memory or amount of knowledge. In this way, the model side steps the difficult task of defining intelligence and becomes applicable to any student, regardless of their personal conceptions. It also avoids getting bogged down in a theoretical debate and, instead, focuses on outcomes.

The second strength of Dweck's model may also be a weakness, and this is that STIs are placed within a network of many other variables. In one way this is realistic because it suggests that STIs work on and with many other variables to impact achievement, instead of proposing that a malleable view of intelligence is the ultimate solution to all achievement woes. In another way, it adds so much gray area to the issue that it can be difficult to determine how useful this construct actually is when predicting learning outcomes. So far the research is unclear on whether there is a direct link between STIs and achievement (Blackwell et al., 2007; Gonida et al., 2006; Good, Aronson, & Inzlicht, 2003; Leondari & Gialamas, 2002), but the research does seem to indicate that at-risk students who adopt a malleable view see an improvement in grades (Blackwell et al., 2007; Good et al., 2003). Leondari and Gialamas (2002) tested the connection between STIs and achievement for a group of middle class, White fourth graders in Greece, and found no direct correlation between a malleable belief and higher achievement. They did, however, find an indirect link between STIs and achievement, mediated by learning goals (Leondari & Gialamas, 2002). Gonida et al. (2006) found that higher achievement led to the adoption of malleable beliefs, but found no connection between malleable beliefs and higher achievement. In a study of students making the transition to middle school, it was found that students who expressed a malleable belief not only avoided a drop in grades over but actually saw an improvement (Blackwell et al., 2007). Although much research has been conducted on STIs and achievement, more needs to be conducted on how STIs can impact the grades of students who are at risk for stereotype threat or dropping out, or who are low-income. It is possible that, for students who are high-achieving, well-supported, and not at risk for stereotype threat, STI may matter little. There are other factors that will continue to push these students toward higher levels of achievement. For students who need the most help, however, it may be that their STI, along with other motivational variables, would have a significant impact on their academic performance. In studies focusing specifically on students who are at risk for lower achievement, stronger ties are found between a malleable view of intelligence and higher achievement levels (Aronson, et al., 2002; Blackwell et al., 2007; Good et al., 2003). However, when the model is applied to learners ranging from low- to high-achievers, the results are not as conclusive (Burns & Isbell, 2007; Gonida et al., 2006; Leondari & Gialamas, 2002).

An additional weakness of this achievement motivation model, as it has been tested by Blackwell et al. (2007), concerns measurement. First, some of the subscales used to investigate the model demonstrate less-than-stellar reliability (Cronbach alphas of .64, .76, and .77 for causal attribution, failure response, and effort belief subscales, respectively). Also, some of the model fit results for this particular model are not as strong as desired (Jones et al., 2011). These results will be discussed further in the following section.

Previous research testing the complete model. Blackwell et al. (2007) were the first to test Dweck and Molden's (2005) suggested model in its entirety. Although Dweck and Molden (2005) initially proposed a version of the model, it is Blackwell et al.'s (2007) tested model, specifically, that the proposed study will examine. As such, I will refer to this model as *Blackwell et al.'s (2007) Model of Achievement Motivation*. In Blackwell et al.'s (2007) analysis, STIs, goal orientation, effort beliefs, attributions, and responses to failure were included as variables, omitting self-esteem and learning strategies. They found that a malleable belief of intelligence led to a mastery goal orientation and positive effort beliefs in seventh grade students in a urban setting. These were positively related to low helpless attributions and positive responses to failure. Low helpless attributions also led to positive responses after failure, and these positive responses led to improved academic outcomes (Blackwell et al., 2007). All paths (see Figure 2) were shown to be significant ($p < 0.05$), and overall, the model explained 27% of the variance in academic achievement. The model demonstrated adequate fit to the data

(RMSEA = .06; p close fit = .03). A non-significant chi-square value was found (χ^2 = 6,044.23; df = 291; $p < .05$). Jones et al. (2011) conducted a similar study, again omitting self-esteem and learning strategies, with a different population (ninth grade students in a rural setting) and found similar significant results between model variables (see Figure 2). Further, they expanded on this model by including interest as a variable in the model. They found that interest served as a partial mediating variable between a malleable belief and a mastery goal orientation (Jones et al., 2011). They also found that, when current math grade was used as an antecedent variable instead of an outcome variable, there was a significant reduction in the chi-square value (χ^2 = 7.84, $p < 0.01$, $df = 1$), demonstrating that this model was a better fit for the data (see Figure 2). With regard to model fit, the data yielded a RMSEA of .14.

Given these findings, it would be useful to have further evidence regarding the inclusion of interest as a variable in the model, as well as the impact of achievement in the model as both an antecedent and an outcome variable. In addition, none of the research to date has examined the role of students' metacognitive knowledge and skills within Blackwell et al.'s (2007) model.

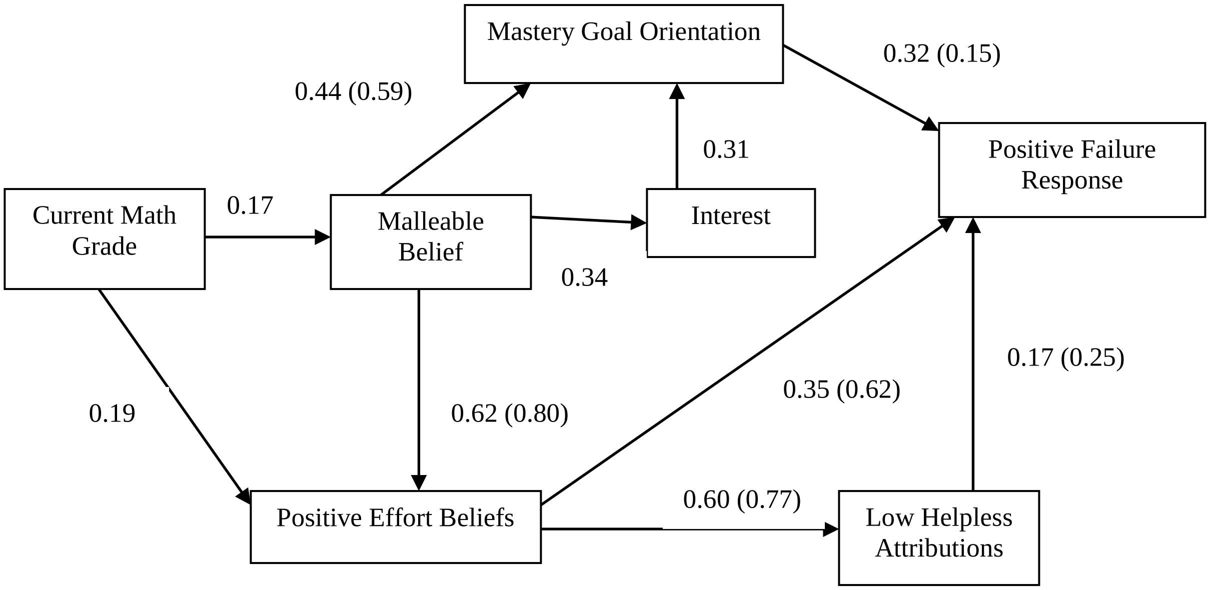

Figure 2. Model of the relationship of STIs to six motivational variables (Jones et al., 2011). Values in parentheses are from Blackwell et al. (2007).

These outcomes supporting Blackwell et al.'s model are preliminary. More research is needed to understand how accurately this model represents the motivation of a variety of populations and domains. Overall, despite some promising findings, more information is needed to understand the strength and usefulness of this model.

The measurement of constructs in Blackwell et al.'s (2007) model. In testing this model, Blackwell et al. (2007) developed a 33-item questionnaire to assess each of the motivational variables. Jones et al. (2011) used a 53-item questionnaire based on Blackwell et al.'s (2007) original instrument. Although this instrument has previously been used twice to investigate this particular model of motivation, no validation studies of the instrument have been conducted. Another issue arises in the labeling of the individual variables. In the Blackwell et al. (2007) investigation, the variable labeled *positive strategies* assesses the likelihood that students will continue to try, or try harder, after experiencing failure. Since STIs have already been linked to greater use of positive learning strategies, this terminology is problematic and can lead to confusion. *Positive strategies*, in this instance, would be more accurately referred to as *positive failure response* or *response after failure*. For the purposes of this study, to begin to address this weakness, this variable will be labeled *positive failure response* to avoid confusion. Because this instrument has not been thoroughly validated, results from its use should be interpreted with this in mind.

The measurement of STIs. The most widely used and validated instrument for measuring STIs is the three-item questionnaire developed by Dweck and Henderson (1988). The three items in this questionnaire are: “You have a certain amount of intelligence and you really can’t do much to change it”; “Your intelligence is something about you that you can’t change very much”; and “You can learn new things, but you can’t really change your basic intelligence.” Respondents indicate on a 6-point Likert scale ranging from 1 (strongly agree) to 6 (strongly disagree) how much they agree with each statement. Respondents are considered to have a fixed view if their overall average score is 3.49 or below; those scoring 3.51 or above are considered to have a malleable view (Dweck et al., 1995).

Several issues have been raised regarding this instrument, one of which is the small number of items. Although three items does seem very meager for assessing an abstract construct, proponents of the instrument point out that each item is intended to have the same meaning, and that addition of any items would make the instrument frustrating or tedious to respondents (Hong et al., 1999). Despite the small number of items, the high internal reliability of the instrument has been demonstrated (alpha ranging from .94 to .98), along with test-retest reliability (r = .80, N = 62, over a two week period; Hong et al., 1999).

Another issued regarding this instrument is the lack of items measuring the malleability of intelligence. Dweck et al. (1995) assert that this is done because malleable items are too appealing, and that in past studies, even fixed theorists begin to drift into more malleable choices as they work through the items. This argument is compelling, but there is a lack of accessible data to verify it. Dweck et al. (1995) cite two studies, one by Boyum (1988) and another by Leggett (1985); Boyum's study is unpublished, and was presented at the annual meeting of the Eastern Psychological Association. Although the high internal and test-retest reliability of the instrument is promising, the lack of malleable items has not been sufficiently addressed. The lack of malleable items also raises another question: does disagreement of fixed items imply endorsement of a malleable view? Dweck et al. (1995) cite a study by Henderson (1990) in which respondents were qualitatively interviewed about their responses on the three items. This study showed that those with a high score on the instrument also expressed malleable beliefs in the interviews; however, these data were also never published. In a more recent study by Quihuis, Bempechat, Jimenez, and Boulay (2002), 57 Mexican-American tenth through twelfth graders were given Dweck's inventory. Thirteen students were then chosen for qualitative interviews. The fixed theorists began their interviews by discussing the unchangeable nature of intelligence, but over the course of the interview these students began to express views that were more consistent with a malleable view (Quihuis et al., 2002). It is possible that the interview questions required the participants to examine their own beliefs more deeply; the interview may have acted as an unintentional intervention. It may also be that fixed views and malleable views are not as mutually exclusive as previously suggested.

With regard to validation, scores on Dweck and Henderson's (1988) instrument have been shown to be independent of the respondents' age, sex, and political or religious affiliation

(Dweck et al., 1995). Further research on the independence of respondents' race or ethnicity from STI scores, along with qualitative research to validate the scores on the measure, would increase the applicability of the instrument. Additional qualitative research is also needed to explore whether or not the rejection of a fixed view is equivalent to the endorsement of a malleable view.

The issues discussed above with regard to Dweck and Leggett's (1988) three-item questionnaire led to the creation of the *Implicit Theories of Intelligence Scale For Children* (Dweck, 2000). This measure is six items long, and includes three malleable items. These malleable items were designed to be less appealing and show a high negative correlation with the fixed items. The fixed items in this measure are the same items used in the three-item questionnaire. It should be noted that the fixed and malleable subscales still have not been subject to qualitative validation. In light of the weaknesses of this measure, it is still, currently, the most valid way to measure STIs.

Metacognition

In this section I discuss metacognition, its relationship to learning and achievement, and the measurement of this construct. The work of John Flavell (1971, 1979) is often viewed as the seed from which the construct of metacognition germinated (Dinsmore, Alexander, & Loughlin, 2008). According to Flavell (1979), metacognition is a developed trait; children have limited knowledge of their own cognition and rarely monitor their own cognitive processes. As they reach adulthood, these children begin to develop their metacognitive awareness. Flavell (1979) theorized that metacognition was comprised of the interactions of four different phenomena: (a) metacognitive knowledge; (b) metacognitive experiences; (c) goals or tasks; and (d) actions or strategies. Goals are the objectives involved in a specific cognitive task, whereas actions are the cognitive exercises or behaviors that an individual uses to achieve these objectives (Flavell, 1979).

Metacognitive knowledge is knowledge that an individual has about the variables that affect cognitive outcomes. Flavell (1979) suggested that this knowledge would fall into three major categories: person, task, and strategy. Person knowledge is any knowledge an individual has about how they, and humans in general, function cognitively. Task knowledge is any knowledge related to the characteristics of the task, such as difficulty, amount of prior knowledge, and available resources. Metacognitive strategy knowledge involves understanding which strategies will be most effective in achieving certain goals.

Flavell (1979) described metacognitive experiences as feelings that an individual experiences before, during, and after a cognitive task. These may be feelings of success, failure, confusion, certainty, or confidence. These metacognitive experiences may provide an individual with the impetus to revise his or her metacognitive knowledge base or to activate the use of strategies (Flavell, 1979).

As for the present state of metacognition, theorists have organized and explained the construct in a variety of ways (Baker & Brown, 1984; Flavell, 1979; Livingston, 1997; Schraw & Moshman, 1995). Flavell's (1978) early definition of metacognition – "knowledge that takes as its object or regulates any aspect of any cognitive endeavor" (p. 4) – included both knowledge and skill elements within it, but it was Baker and Brown (1984) who later drew attention to the dichotomous nature of this definition. According to them, metacognition includes two separate but interrelated components: knowledge of cognition and regulation of cognition (Baker & Brown, 1984). The former component was broadly described as knowledge that a person has about their cognition and their relation to the learning situation. The second component incorporated six actions and mechanisms that individuals use to regulate their thinking: checking, planning, monitoring, testing, revising, and evaluating. Baker and Brown (1984) stated that individuals check whether they have been successful in reaching their goal, plan for future actions, and monitor their progress toward a goal. Individuals may also analyze the strategies they use to reach their goals through testing, revising, and evaluating.

Schraw and Moshman (1995) further elaborated on the two-part definition of metacognition, and stated that three kinds of metacognitive knowledge exist: declarative, procedural, and conditional. Declarative metacognitive knowledge refers the individual's knowledge about his or her own learning as well as human learning in general. Procedural knowledge is the knowledge the individual has about the use of specific skills. Finally, conditional knowledge is knowledge that the individual has about when and why to employ certain skills. When discussing the regulatory element of metacognition, Schraw and Moshman (1995) distilled the current literature of the time, and only included three mechanisms that were present in nearly every definition of metacognition: planning, monitoring, and evaluation. Here, the term *evaluation* refers to the act of reflecting on an event or task and assessing whether or not the goal was achieved, (similar to Baker and Brown's [1984] *checking* mechanism).

Livingston (1997) offered another organizational framework for the construct of metacognition. Similar to its predecessors, this framework included both the knowledge and regulatory components. However, instead of using Schraw and Moshman's (1995) three-part definition, Livingston (1997) revived Flavell's earlier definition by incorporating knowledge of person, task, and strategies variables within the metacognitive knowledge component. Currently, many of the researchers employ a two-part model of metacognition that combines aspects of these different suggested models (see Table 1).

Table 1

Model of Metacognition (Schraw & Dennison, 1994)

Knowledge of Cognition	Regulation of Cognition
Declarative	Planning
Procedural	Information management strategies
Conditional	Comprehension monitoring
	Debugging strategies
	Evaluation

Flavell's (1971, 1979) and other early theorists' conceptions of metacognition were focused more internally on mind and individual differences and less on observable behaviors (Dinsmore et al., 2008). Metacognition was developed through introspection and learner development. According to Moshman (1982), metacognition can be categorized as *endogenous constructivism*, meaning that metacognition's focus is on the individual's ability to construct knowledge through an internal, introspective process. Baker and Brown (1984) expanded this definition of metacognition by including a regulatory element, and the construct of metacognition began to bleed over into the concept of self-regulation.

At this point, it is useful to differentiate between metacognition, self-regulation, and self-regulated learning. Dinsmore et al. (2008) have previously discussed the fact that metacognition, self-regulation, and self-regulated learning have discrete theoretical backgrounds. The construct of metacognition is often credited to the work of Flavell in the 1970s (Dinsmore et al., 2008), and its theoretical roots stretch back to the work of developmental theorists such as Piaget and cognitive theorists such as William James (Fox & Riconscente, 2008). Researchers investigating metacognition focus is on the internal processes of the mind and how these become more self-aware and refined over time (Dinsmore et al., 2008). Self-regulation, on the other hand, is often credited to the work of Albert Bandura in the 1980s (Dinsmore et al., 2008). As a construct, self-regulation is focused on the interactions of the learner with the environment and the observable behavior of the individual. Compared to metacognition, self-regulation has a more outward, external orientation. However, these lines began to blur when metacognition theorists began to include a regulatory element (Baker & Brown, 1984). As they were originally conceived, neither metacognition nor self-regulation was applied to learning events that specifically took place in the classroom. Over time, researchers began to apply these concepts more frequently to investigations of classroom learning, and a third construct, self-regulated learning, began to emerge. According to Dinsmore et al. (2008), self-regulated learning's theoretical underpinnings are drawn from both metacognition and self-regulation, giving it a focus that is internal and external, cognitive and behavioral.

Metacognition is the appropriate focus for this study for two reasons: first, my focus is less on learner-environment interactions and more on the internal, individual differences of the learner. Specifically, my focus is on how the individual's conceptions of intelligence interact with their metacognitive knowledge and skills to ultimately impact achievement. Secondly, my focus is more developmental in nature. Instead of investigating how the student will behave in one finite circumstance, I intend to focus on how the individual's STIs and metacognition have developed, and co-developed, over time. Despite the fact that all of the previously discussed frameworks vary to some degree, there is one point where they converge. Although Flavell (1979) focused mainly on the knowledge component of metacognition, he did include both components within his definition. All of the frameworks previously discussed acknowledge a dual-component definition of metacognition, and so, for the purposes of this paper, I will define metacognition as comprising both metacognitive knowledge as well as metacognitive skill.

Metacognition and learning. Metacognition is important to develop in learners for several reasons. Metacognition has been linked to intelligence (Livingston, 1997), and metacognitive awareness has been shown to improve the likelihood that learners will transfer knowledge to new contexts with less prompting from teachers (Bransford, Brown, & Cocking, 2000). By encouraging metacognitive awareness, teachers can help their students become more effective learners. Different students will have different levels of metacognitive knowledge and skills, and some research has shown that those with more refined metacognitive abilities perform better in school (Zulkiply et al., 2008). Other researchers have tied metacognition to a more autonomous style of learning (Cubukcu, 2009) and better strategy use (Garner & Alexander, 1989).

Researchers have also linked metacognition to academic performance (Sungur, 2007). Fifty-eight college students enrolled in a statistics class were asked to complete the Metacognitive Awareness Inventory (MAI). They were then given two essay-style tests on material from the course. One essay was inconsequential in that students were told there would be no consequences for their grade. The other was consequential, and would count toward their class grade. Sungur (2007) found that, for the consequential condition, a higher metacognitive score predicted better performance on the essay. No relationship was found between metacognition and performance for the inconsequential condition (Sungur, 2007).

Legg and Locker (2009) found that metacognition moderated the relationship between math anxiety and math performance. Fifty-six undergraduate students were given the Revised Math Anxiety Rating Scale (RMARS) to assess the students' general math anxiety. Then, after completing 20 arithmetic problems, students were given the State Metacognitive Inventory (SMI) to assess students' metacognition within the context of the task (Legg & Locker, 2009).

The researchers found that math anxiety significantly predicted performance on the arithmetic problems. Higher scores on the SMI also predicted math performance. Importantly, the researchers found that for students with high anxiety levels, math performance decreased as their SMI scores decreased (Legg & Locker, 2009). This is important because it suggests that metacognition may not only reduce general math anxiety for some students, but it may buffer students with high anxiety from failure in regards to math performance.

Metacognitive skills may also buffer students with lower aptitude levels from failure (Swanson, 1990). A bimodal sample of fourth and fifth grade students of high and low cognitive ability was given a metacognitive questionnaire and two problem-solving tasks. Swanson (1990) found that high-metacognitive students out-performed low-metacognitive students regardless of their cognitive ability. Swanson (1990) suggests that high-metacognitive students' ability to make use of strategies may help them perform better on the problem-solving tasks, mediating the effects of a lower aptitude level. These findings indicate that development of metacognitive skills and strategies may be helpful to students with a history of low academic achievement, and may lead to better performance in school. Other researchers have found similar results. In a study of South African students, Maqsud (1997) found that, for students with low academic ability, those with high metacognitive ability significantly out-performed those with low metacognitive ability on mathematics and English tests. Two studies were conducted to investigate the effect of metacognition and general academic ability on math and English performance. In the first study, 140 South African high school students were given Swanson's (1990) metacognitive questionnaire, the Raven's Progressive Matrices to test general ability, and a mathematics achievement test. The results showed that for the high ability and low ability groups, the students with higher metacognitive scores significantly out-performed those with lower metacognitive scores (Maqsud, 1997). The same results were found in the second study, where students were given an English comprehension test in place of the mathematics achievement test (Maqsud, 1997).

In an additional illustration of how metacognitive abilities may support students at a disadvantage, Trainin and Swanson (2005) investigated the difference between metacognitive skills of students with and without learning disabilities. The study compared a group of 20 college students with learning disabilities to a group of non-learning disability students that was comparable in class standing, major, racial/ethnic makeup, and gender. The researchers found no significant differences between the groups for academic achievement, motivation, self-efficacy, or metacognitive knowledge (Trainin & Swanson, 2005). They did find, however, that the students with learning disabilities scored significantly higher on the self-regulation component of metacognition than their non-learning disabled counterparts (Trainin & Swanson, 2005). The researchers suggest that it was the use of metacognitive strategies, specifically those related to self-regulation, which allowed the students to work around their learning disability and be successful in the college setting (Trainin & Swanson, 2005).

In a study of Malaysian high school students, researchers found a correlation between students' scores on the MAI and their exam scores (Zulkiply et al., 2008). Researchers also found significant differences in students' metacognitive scores by age (Zulkiply et al., 2008), which suggests that metacognition is a skill that develops over time. If this is the case, then teachers may be able to expedite this process by providing students with opportunities to engage in metacognitive activities. Overall, the results of this study demonstrate again the fact that metacognitive ability may help students perform better academically.

The research has shown that more developed metacognitive knowledge and skills may protect students from the negative effects of performance anxiety, provide an advantage to students with lower ability levels, moderate the effects of a learning disability, and may help students perform better in assessment situations, (Legg & Locker, 2009; Maqsud, 1997; Sungur, 2007; Swanson, 1990; Trainin & Swanson, 2005). Research has also shown that individual students have different levels of metacognitive abilities and that these abilities develop over time (Zulkiply et al., 2008).

The measurement of metacognition. As this study adds metacognition to the existing model, and requires the selection of an appropriate measure, in this section I will discuss various inventories that have recently been used to assess students' metacognitive knowledge and skills. Three of the most frequently used inventories in the current literature are the Learning and Study Strategies Inventory (LASSI), The Motivated Strategies for Learning Questionnaire (MSLQ), and the Metacognitive Awareness Inventory (MAI). A fourth and recently developed inventory, the Junior Metacognitive Awareness Inventory (*Jr. MAI*), restructured the MAI to make is suitable for younger students. This section will also include a brief justification for the use of the use of the *Jr. MAI* in this study.

LASSI. Please note that I obtained all of the information in the following paragraph from Weinstein and Palmer (2002). The LASSI is described by its developers as a "10-scale, 80-item assessment of students' awareness about and use of learning and study strategies related to skill, will and self-regulation components of strategic learning," and is intended for use with post-secondary students (Weinstein & Palmer, 2002, p. 4). The LASSI was created as a means to assess learning and study strategies courses in undergraduate programs; these courses were being developed to address the under-preparedness of incoming students. The theoretical basis for this inventory is described as *strategic learning*, not metacognition theory. In fact, when stating the inventory's purpose, the developers do not use the word "metacognition." The inventory is intended to measure three components of strategic learning: skill, will, and self-regulation. As a result, the LASSI does not measure metacognitive knowledge, only metacognitive skills. The eight scales of the inventory are *Anxiety, Attitude, Concentration, Information Processing, Motivation, Selecting Main Ideas, Self Testing, Study Aids, Test Strategies,* and *Time Management*. The *Anxiety* scale is intended to assess how apprehensive students are when approaching an academic task ($\alpha = 0.87$). Low scores on this scale indicate that the students need to learn strategies for coping with academic anxiety and worry so that these factors will not negatively impact their performance. To measure students' motivation to succeed and general attitude about school, the *Attitude* scale measures how relevant students believe school to be to their life goals ($\alpha = 0.77$). Lower scores on the *Attitude* scale indicate that the students need to learn to set higher goals for themselves and consider how schooling fits into their future. The *Concentration* scale of the LASSI measures how well students can direct their attention to school and study activities ($\alpha = 0.86$). A high score on this scale means that the student can maintain a high level of concentration and focus on academic tasks. The *Information Processing* scale assesses how well the student can foster their own understanding and recall ($\alpha = 0.84$). When a student scores low on this scale, he or she needs to learn methods for organizing and imparting meaning to new information. The *Motivation* scale in intended to assess the degree to which students take responsibility for performing the specific details related to an academic task ($\alpha = 0.84$). Students who score low on this scale need to work on setting goals for completing individual tasks and assignments. The *Selecting Main Ideas* scale measures the respondent's ability to identify and concentrate on important ideas from readings, lectures or autonomous learning events ($\alpha = 0.89$). A low score on this measure indicates that the respondent needs to develop his or her ability to identify the important points within the material for a class. The *Test Strategies* scale assesses students' use of test-taking skills and test preparation strategies ($\alpha = 0.80$). Low scores here may mean that more information is needed on how to prepare for and take tests, regardless of how much of the content matter is known or understood. The items in *Self Testing* assess how well the students monitor their own understanding and review the material ($\alpha = 0.84$). Students with a low score on this scale need more information on self testing and how it can be used to assess their comprehension. *Study Aids* items are intended to measure how well the students can develop study aids that support their learning ($\alpha = 0.73$). Low scores on this scale indicate that students need help developing more or more effective study aids from class materials. The *Test Strategies* scale looks at students' use of test-taking and test preparation strategies ($\alpha = 0.80$). Lower scores on the *Test Strategies* scale indicate that students need more information on preparing for different kinds of tests and how to make reasoned choices of test items. Finally, the *Time Management* scale measures how well students can develop and use schedules ($\alpha = 0.85$). Respondents with a low score on this scale may need help creating a schedule and dealing with procrastination. Development of the LASSI began in the early 1980s, and the second edition of this inventory is currently being used. This edition provides national norms based on a broad sample taken from 12 different educational institutions.

There are several pros in using the LASSI. First, it was designed to be as user-friendly as possible, in that questionnaire can be quickly scored by the administrator or by the users themselves (Weinstein & Palmer, 2002). The LASSI questionnaire has also been extensively validated with a variety of post-secondary populations and its subscales have demonstrated a high internal reliability (Weinstein & Palmer, 2002). The largest con to using the LASSI is that it is not designed to specifically assess metacognitive knowledge and skills, though it has been used previously to this end (Ommundsen et al., 2005). Arguably, the eight scales together would provide some insight as the individual's knowledge and regulation of cognition. However, the LASSI is not based on metacognition theory or literature. Therefore, although scores from the instrument are reliable and well-validated, it is not the most accurate measure for metacognition.

MSLQ. According to its creators, the MSLQ is "a self-report instrument designed to assess college students' motivational orientations and their use of different learning strategies for a college course" (Pintrich, Smith, Garcia, & McKeachie, 1991, p. 3). This instrument is divided into two parts: a motivation section and a learning strategies section. The motivation section is comprised of *Value*, *Expectancy*, and *Affect* components. The learning strategies section includes two components: a *Cognitive and Metacognitive Strategies* component and a *Resource Management* component. There are a total of 15 scales in the MSLQ (Please note that I obtained all of the information provided in this section on the MSLQ scales and alpha scores from Pintrich et al., 1991).

Within the motivation section, the *Value* component contains scales for intrinsic goal orientation, extrinsic goal orientation, and task value ($\alpha = 0.74, 0.62, 0.90$). These scales measure the perceived reasons the student is participating in the academic task, as well as how interesting or important the academic task itself is. The *Expectancy* component is comprised of two scales: control of learning beliefs and self-efficacy for learning and performance ($\alpha = 0.68, 0.93$). The two scales assess the student's beliefs about the impact of effort, beliefs about their ability to master a task, and expectations for success. The *Affective* component contains the test anxiety scale ($\alpha = 0.80$). This scale is intended to measure the student's cognitive and physiological response to test situations. In other words, do the students experience negative thoughts and worries before taking a test? Do they experience a level of arousal consistent with an anxious state?

Within the learning strategies section, the *Cognitive and Metacognitive Strategies* component includes five scales: rehearsal, elaboration, organization, critical thinking, and metacognitive self-regulation (α = 0.69, 0.76, 0.64, 0.80, 0.79). These five scales measure how the student uses strategies to retain and transfer knowledge. The *Resource Management Strategies* component includes four scales: time and study environment, effort regulation, peer learning, and help seeking (α = 0.76, 0.69, 0.76, 0.52). The scales within this component assess how the student manages material and social resources to obtain academic goals.

Development of the MSLQ began in 1986 as a way to assess progress in a learning strategies class. The 15 scales can be used together or individually, depending on the researcher's needs. Unlike the LASSI, the MSLQ does not include any national norms for comparison. This is because this instrument is intended to be used at the classroom level. The MSLQ is not as user-friendly as the LASSI; it is harder to score and give feedback. However, the feedback that respondents receive from the instrument is much more in-depth than the LASSI. The MSLQ is not based on metacognition theory, though the *Cognitive and Metacognitive Strategies* component does measure skills aspect of the metacognition construct. According to Pintrich et al. (1991), "We have focused on the control and self-regulation aspects of metacognition on the MSLQ, not the knowledge aspect" (p. 23). Scores from the MSLQ are well-validated, and while the internal reliability for some of the scales are lower than that of the LASSI, they are generally acceptable, ranging from 0.52 to 0.93 (Pintrich et al., 1991).

Although the instrument was not created to measure metacognition, it has been used in previous research to do just that (Abdullah, 2008; Trainin & Swanson, 1995). Trainin & Swanson (1995) used the MSLQ in its entirety to measure university students' metacognitive knowledge and skills. Abdullah (2008) used the learning strategies section to measure 10 to 12 year olds' metacognitive skills and self-regulation. The items were shortened and simplified to make them appropriate for a younger sample of students (Abdullah, 2008). If the overall goal of the research is to assess the metacognitive skills (or regulation of cognition), aspect of metacognition, then the MSLQ is a useful instrument. To measure the construct as a whole, it is not the most accurate measure.

MAI. Unlike the LASSI and the MSLQ, metacognition theory is the foundation of the MAI (Schraw & Dennison, 1994). The instrument was developed for two reasons: to assess adolescent and adult students' metacognitive knowledge and skills; and to investigate the dual-component model of metacognition and its eight sub-factors (Schraw & Dennison, 1994). Under metacognitive knowledge, the theory states that learners may possess declarative, procedural and conditional knowledge about cognition (Schraw & Dennison, 1994). Under metacognitive skills, learners use planning, information management, monitoring, debugging, and evaluation to regulate their cognition (Schraw & Dennison, 1994). The researchers used a continuous scale, as opposed to a Likert-type scale, for the MAI, and this was for two reasons. First, the goal was to "provide a better approximation to interval data compared to Likert scales" (Schraw & Dennison, 1994, p. 463). Secondly, the researchers wanted to increase the variation in responses through a 100 point scale, thereby increasing the reliability of the measure (Schraw & Dennison, 1994). The results of the factor analysis supported the dual-component theory of metacognition (Schraw & Dennison, 1994). However, the researchers found six sub-factors instead of eight.

Metacognitive knowledge was found to include personal knowledge of strengths and weaknesses, and knowledge of strategies and when and why to use those strategies (Schraw & Dennison, 1994). The metacognitive skills component included planning, implementing, monitoring, and evaluating the use of strategies (Schraw & Dennison, 1994). Internal reliability ranged from 0.88 to 0.93 for these scales (Schraw & Dennison, 1994). The instrument contains 52 items and is user-friendly in that it is easy to administer. However, like the MSLQ, no norms are provided to help administrators in interpreting students' scores. Overall, this instrument is based on metacognition theory and is a reliable, accurate measure for this construct, and has been used in previous research on metacognition (Lee, Teo, & Bergin 2009; Schleifer & Dull, 2009; Stankov & Lee, 2008; Sungur, 2007).

Jr. MAI. The MAI is a reliable, accurate way to assess students' level of metacognitive knowledge and skills. However, it is only appropriate for adults. In order to assess metacognitive knowledge and skills in young students, specifically middle school students, the *Jr. MAI* (Sperling, Howard, Miller, & Murphy, 2002) is the more appropriate measure. The *Jr. MAI* is available in two versions. Version A is appropriate for students in grades three through six, and Version B is appropriate for sixth to ninth grade students (Sperling et al., 2002). Both versions were created using Baker and Brown's (1984) two-component model. Sperling et al. (2002) conducted factor analyses to see whether the items loaded onto two distinct components. To further address the validity of the measure, they also compared *Jr. MAI* scores to scores on other inventories designed to measure a similar construct. Version B, comprised of 18 items, is appropriate for this study; therefore it will be the focus of the discussion here. An initial exploratory factor analysis revealed the items loading onto five factors. In a forced two-factor exploratory analysis, six of the nine items representing metacognitive knowledge loaded onto one factor. All of the nine items addressing metacognitive skills loaded onto one factor. The two-factor solution accounted for 36% of the variance. Sperling et al. (2002) found that Version B was significantly correlated with other self-report measures of metacognition, the strongest correlation share with the Strategic Problem Solving Inventory. Significant, albeit moderate, correlations were also found between Version B and the Metacomprehension Strategies Index and the Index of Reading Awareness. Version B scores were not correlated with the teacher's ratings of students' metacognition. These findings are preliminary, and this measure is in its germinal stage. Scores from this measure must be interpreted accordingly. In spite of the weaknesses of this measure, it is still the strongest choice for measuring a bi-modal model of metacognition in middle school students.

Summary. These three inventories, the LASSI, MSLQ, and MAI, have been widely used in the study of metacognition (Abdullah, 2008; Lee et al., 2009; Ommundsen et al., 2005; Schleifer & Dull, 2009; Stankov & Lee, 2008; Sungur, 2007; Trainin & Swanson, 2005), and each has its pros and cons. The LASSI and the MSLQ have been validated in a range of studies and, although they are not based on metacognition theory, they may be used to measure metacognition, or at the very least the skills component of metacognition. The MAI boasts high scores for internal reliability, and has the dual-component theory of metacognition as its basis. It is an accurate assessment for both the knowledge of cognition and the regulation of cognition. Of the four instruments, it is the most accurate choice to measure metacognition in its entirety. For younger students, the *Jr. MAI* is the most appropriate choice.

All four of these measures use items that require self-reports, which can be problematic. Although self-reported measures like the LASSI, MSLQ, MAI, and *Jr. MAI* are frequently used by researchers studying metacognition, researchers rarely address the issue of whether or not self-reports accurately reflect metacognitive behaviors (Schunk, 2008). Future research should address this question to provide researchers and practitioners with information that can be used to help students develop metacognitive knowledge and skills.

STIs and Metacognition: Why This Relationship Matters

The link between STIs other motivational variables suggests that a correlation may exist between self-theories and metacognition. Understanding this relationship would be valuable, in that it may allow researchers and practitioners to gain a better understanding of how to encourage the development of a malleable view of intelligence, as well as metacognitive knowledge and skills in students.

As previously discussed, researchers have documented that more developed metacognitive knowledge and skills may protect students from the negative effects of performance anxiety, provide an advantage to students with lower ability levels, moderate the effects of a learning disability, and may help students perform better in assessment situations (Legg & Locker, 2009; Maqsud, 1997; Sungur, 2007; Swanson, 1990; Trainin & Swanson, 2005). Researchers have also documented that individual students have different levels of metacognitive abilities and that these abilities develop over time (Zulkiply et al., 2008). These findings lead to the question: Aside from teacher intervention, what may lead some students to refine their metacognitive abilities while others do not? One possible explanation may be their view of intelligence. Students who believe they can cultivate their intelligence may be more likely to reflect on their level of knowledge and how they obtain their goals. Researchers have already demonstrated that students with a malleable belief are more inclined to use learning strategies that require more effort and result in deeper learning (Blackwell et al., 2007; Jones et al., 1993; Ommundsen et al., 2008). Jones et al. (1993) compared students holding a malleable view to students holding a fixed view with regard to study skills and strategies. The malleable view students used strategies that focused on deeper levels of learning; fixed view students were more likely to use rote learning study skills. In a study of pre-service teachers, Ommundsen et al. (2005) found that a malleable view of intelligence correlated with higher self-regulatory skills and strategies that involved deeper processing of information. These results have been found with younger participants, as well. For a group of children age 10 to 12 years old, Abdullah (2008) found that malleable beliefs predicted self-regulated learning behavior. That is, students who held the belief that intelligence could be enhanced were more likely to make use of learning strategies (Abdullah, 2008).

Despite the fact that both of these studies aptly display the connection between STIs and self-regulation, they still leave gap in the knowledge regarding students' STIs and metacognition. Ommundsen et al. (2005) used three subscales of the Learning and Study Strategies Inventory (LASSI; motivation, information processing, and concentration) and Abdullah (2008) and Jones et al. (1993) used the Motivated Strategies for Learning Questionnaire (MSLQ); however, both the LASSI and the MSLQ fail to capture metacognition as a complete construct. These measures provide insight into students' metacognitive skills, but do not assess metacognition as a complete construct. To address this gap, it would be necessary to use an instrument that included items assessing both students' metacognitive knowledge and students' metacognitive skills and strategies.

Given that researchers have demonstrated a relationship between STIs and metacognitive skills (Abdullah, 2008; Blackwell et al., 2007; Jones et al., 1993; Ommundsen et al., 2005), the next step in the research is to examine the relationship between metacognition as a complete, bi-modal construct (knowledge and skills) and STIs. It should also be noted that, with regard to

Blackwell et al.'s (2007) model, both metacognitive knowledge and skills have not yet been investigated. The relationship of STIs and metacognition, as yet unconfirmed, is supported by what is known thus far in the research. It is known that students with a malleable belief are more likely to have better metacognitive skills and learning strategies. It is also known that a malleable belief has very specific consequences for other motivational variables. In much the same way that a malleable belief may lead students to believe that increased effort leads to more positive outcomes by increasing their ability (Dweck & Leggett, 1988; Hong et al., 1999; Jones et al., 1993), it is possible that a malleable belief may encourage students to increase their metacognitive knowledge and skills. Students who believe that their intelligence can be influenced will be more likely to investigate how they learn and what strategies should be used in order to impart positive change on their abilities. In turn, having knowledge of themselves as learners and having a toolbox of skills to apply to a learning task could lead students to the belief that their efforts will often be effective and will lead to positive outcomes. There is preliminary research to support this hypothesis: in a study testing a different model of student motivation through path analysis, Sungur (2007) found that control of learning beliefs (defined in the study as the belief that ability to learn can be controlled through effort) impacted metacognitive strategy use, which then impacted effort regulation. Sungur (2007) defines *effort regulation* as the adjustment of effort after failure through the use of new strategies, which is closely related to effort beliefs as they are conceived in the proposed study: the belief that increased effort will result in increased positive outcomes. Although Sungur's (2007) study measured only metacognitive strategy use and neglected metacognitive knowledge, it supports the hypothesized connection between STIs, metacognition, and effort beliefs. Considering the previous research, I propose that metacognition (as a two-component construct) may play a mediating role between STIs and effort beliefs.

Investigating this relationship has real-world applications. In fleshing out Blackwell et al.'s (2007) model, a greater understanding of the relationship of STIs to other motivational variables will emerge. This greater understanding will help educational researchers determine the overall usefulness of this model in positively impacting academic outcomes for students. Specifically, once the validity of the model and the construct has been adequately established, this information can also inform the development of psychosocial interventions. In the following sections, I will discuss the practical applications of understanding this model with regard to psychosocial interventions, STI interventions, and the middle school transition.

Psychosocial interventions and previous STI interventions. Yeager and Walton (2011) define psychosocial interventions as "brief exercises that target students' thought, feelings, and beliefs in and about school" (p. 1), and posit that seemingly short interventions have been shown to have a lasting impact on students' academic achievement. Interventions reviewed by Yeager and Walton were created to influence students' attributions, affirm students' positive values, increase social belonging, make course content personally relevant, and impact STIs. They reported that students continue to experience positive outcomes from these experiences for years after their completion (Yeager & Walton, 2011).

With specific regard to STIs, the research on these interventions may appear inconclusive due to conflicting results reported in different studies. Some researchers have found that encouraging students to develop a malleable belief resulted in better academic performance when compared to students with fixed theories (Aronson, et al., 2002; Blackwell et al., 2007; Good et al., 2003). Other researchers found that priming participants with a malleable view of intelligence was not associated with an increase in performance (Burns & Isbell, 2007; El-Alayli & Baumgardner, 2003). There is, however, one important difference between these two groups of studies: when participants of the interventions were either low-achieving or at-risk students, the researchers found an improvement in performance. This finding is noteworthy because it suggests that low-achieving or at-risk students may be an important target group for STI interventions.

Aronson et al. (2002) demonstrated this result in their study using an STI intervention to reduce the effects of stereotype threat in African American college students. The participants in the study (42 Black, 37 White) were randomly assigned to three different conditions: a malleable pen pal condition, a control pen pal condition, and a non-pen pal condition. In the first condition, students were provided with a summary sheet of recent research suggesting that the brain can grow new connections, and that intelligence can be enhanced over time. They were also shown a video to reinforce these ideas. The participants were then asked to respond to their pen pals by writing encouraging letters that incorporated this research on human intelligence. Participants in the second condition were also asked to write letters of encouragement to their middle school pen pals, however, this group was instructed to incorporate an underlying message of intelligence that stressed that humans could be intelligent at different things, and while one student may have a weakness in one area, he or she may also have strengths in others. In the final condition, students did not write pen pal letters. For all conditions, grades and SAT scores were obtained. The researchers found that, not only did the intervention instill a malleable belief within the participants of the experimental condition initially, but that this effect also persisted well after the intervention (Aronson et al., 2002). Over time, the difference in beliefs about malleability between the experimental and control condition participants increased even further.

Further, not only did the intervention work in cultivating a malleable view of intelligence, but participants in the experimental condition also went on to achieve higher grades, and this effect was most significant for Black participants (Aronson et al., 2002). The researchers in this study demonstrated that it is possible to affect long term change in students' conceptions of intelligence, and that a malleable view may be a valuable asset to Black students at risk for stereotype threat.

In another study addressing stereotype threat, researchers used an STI intervention to aid students susceptible to stereotypes regarding females in mathematics and the general academic abilities of Black, Hispanic, and low-income students (Good et al., 2003). Similar to the procedure used in Aronson et al. (2002) study, researchers paired 25 college students from the University of Texas with 138 seventh graders. Of the middle school students, 67% were Hispanic, 13% were Black, and 20% were White. In addition, 70% were eligible for reduced price or free lunches, and 45% were female. According to the researchers, the demographics of the participants ensured that the vast majority of middle school participants were susceptible to some form of stereotype threat (Good et al., 2003). Each college student mentored approximately six middle school students, after being trained in communicating one of four experimental messages. In the first condition, college mentors emphasized a malleable belief message, telling middle school students that intelligence is not predetermined but can be improved over time. The second, or attribution, condition, had mentors convey the message that encouraged students to attribute their successes and failures to the amount of effort put forth, as opposed to considering them an indicator of their ability. Middle school students in the third experimental condition received both the malleable belief and attribution messages from their college mentors. Finally, students in the control condition received a message about the hazards of drug use, including health and academic risks, from their mentors. The middle school students' scores on the Texas Assessment of Academic Skills (TAAS), the annual standardized test, were used to determine which experimental condition helped the most in buffering against stereotype threat.

The results illustrated that, for mathematics, the gap between female and male students' scores were no longer significant in all conditions except the control condition (Good et al., 2003). Interestingly, male students in the incremental condition scored significantly higher on the math test than their counterparts in the control conditions. For the reading scores on the TAAS test, students in the malleable, attribution, and combined conditions scored significantly higher than the students in the control condition (Good et al., 2003). It is important to note that there were no significant differences in performance for the malleable, attribution, and combined conditions (Good et al., 2003). This is most likely due to the fact that the two different messages are indeed very similar. A malleable belief about intelligence affects a students' performance because it is so closely tied to the attributions the students make about their outcomes. Here, the researchers have offered reinforcement of the conclusion that it is, in fact, possible to influence an individual's belief about intelligence, and that certain beliefs can be beneficial or damaging, depending on the student. Also important is the utilization of STI interventions to help seventh graders avoid a drop in academic achievement while they navigate the transition to middle school.

Blackwell et al.'s (2007) addressed the transition to middle school, and again demonstrated the usefulness of STI interventions in helping students avoid the usual drop in grades. This study also simultaneously worked with students at a high risk for stereotype threat: of the participants, 52% were African American, 45% were Latino, and only 3% were Asian or

White. The participants were also described as relatively low-achieving. Students were randomly assigned to experimental and control groups. All students participated in eight 25 minute workshops once a week, the content of which depended upon which condition the students had been assigned to. Students in both conditions learned basic facts about the physiology of the brain, antistereotypic thinking, and study skills. Students in the experimental condition learned that the brain is changeable and new connections are formed when learning takes place. These students also learned that the brain was like a muscle, and that continued use increased its strength. Students' math scores were obtained three times: in the spring of their sixth grade year, before transitioning to middle school; at the end of the fall of their seventh grade year, before the intervention took place; and finally, at the end of the spring of their seventh grade year, post-intervention. All participants experienced a significant drop in grades between their sixth grade scores and their fall seventh grade scores. For students in the control condition, grades continued to drop significantly from fall of seventh grade to the spring of seventh grade. For the experimental condition, however, the drop in grades was not only halted, but math scores showed a slight, non-significant, increase from fall of seventh grade to spring of seventh grade. For this group of students who were at-risk for a drop in academic performance while making the transition to middle school, a malleable view of intelligence buffered them from this negative effect with regard to their math scores. This result is promising; however, it would have been informative to have seen how this intervention impacted the students' grades in other areas, such as English or science.

In addition to providing a bulwark for some students against stereotype threat and academic difficulty, a malleable view of intelligence can also reduce the anxiety some students feel when approaching a learning task. Burns and Isbell (2007) demonstrated this in their study of math performance of female undergrads; their results also showed that students experienced a decrease in performance anxiety after the malleable prime (Burns & Isbell, 2007). Martocchio (1994) reported similar results in a study of university employees. These employees participated in a computer skills training course and were primed with either a fixed or malleable view of ability. Their anxiety levels were assessed twice: once before the prime and the training course and once after. The participants who were given the malleable prime before the computer training experienced a significant drop in their performance anxiety levels between the pre- and post-tests (Martocchio, 1994). These participants also experienced a significant increase in computer efficacy beliefs (Martocchio, 1994). Participants who were given the fixed prime experienced no change in performance anxiety and a significant decrease in computer efficacy beliefs between the pre- and post-tests (Martocchio, 1994). For students at risk for stereotype threat, a decrease in performance anxiety may help improve their performance.

Overall, findings from these types of studies show that interventions may be an effective way to cultivate a malleable view of intelligence, buffer students from stereotype threat, and improve academic performance for at-risk students. Such promising findings for such simple interventions, especially programs that only address feelings and beliefs, and teach no content or skills, have understandably drawn skepticism from the educational research community (see Yeager & Walton, 2011, for a discussion). These findings also make it increasingly important to replicate these findings and expand the body of knowledge to determine whether the theoretical foundations for these interventions are truly reflected in the data. To completely understand how impacting one aspect of a student's belief system (such as STIs) can impact his or her academic outcomes for years to come, it is first necessary to understand how STIs function within a network of motivational variables. By influencing one variable within this network, it is possible that psychosocial interventions indirectly impact an entire web of motivational variables. Determining this requires further investigation of the model, and cultivating a deeper understanding of the interrelations of the variables. If metacognition belongs in the model, as research suggests, it could impact the way these interventions are developed. It is possible that addressing the development of metacognitive knowledge and skills, in addition to nurturing a malleable STI, would result in more effective interventions. More information is necessary, however, to determine whether the promise of psychosocial interventions has been overstated.

The middle school transition. Research furthering our understanding of Blackwell et al.'s (2007) model, the role that metacognition may play within the model, and the extent of this model's usefulness in predicting students' achievement motivation may also be vital in addressing the achievement and motivation dip that typically takes place during the middle school transition. It has been suggested that the environments in many middle schools do not meet the needs of young adolescent students, and that the transition from elementary to middle school may be a challenging time for students (Anderman & Maehr, 1994; Anderman & Midgley, 1997; Chung, Elias, & Schneider, 1998). This additional stress can lead some students to experience drop in grades, lowered self-efficacy, and disidentification with school (Anderman & Midgley, 1997; Gutman & Midgley, 2000).

Young adolescents may have social and cognitive needs that differ from those provided by the typical middle school environment (Anderman & Maehr, 1994). Such environments usually provide little room for students to practice making important decisions. Since the middle school environment is typically larger than the elementary school environment, this usually results in stricter rules and discipline, more distant teacher-pupil relationships, and reorganization that often results in the dissolution of students' previous social networks

(Anderman & Maehr, 1994). Early adolescents, on the other hand, are just becoming more autonomous and independent, and rely heavily on their friend groups. This results in what Anderman and Maehr (1994) refer to as a "mismatch" between young adolescent needs and the middle school setting. This "mismatch" may explain the declines in motivation, achievement, and self-efficacy during this transition (Anderman & Midgley, 1997; Gutman & Midgley, 2000).

Anderman and Midgley (1997) demonstrated that the transition to middle school also resulted in a change in self-esteem, perceived academic competence, and mastery orientation. According to self-report measures, students perceived a mastery- or task-focused orientation in the elementary school environment. When the students were surveyed after their transition to middle school, they reported a performance-focused orientation in their schools (Anderman & Midgley, 1997). Overall, the students experienced declines in year-end grades, self-esteem, and perceived competence (Anderman & Midgley, 1997). In a similar study, researchers found that students who perceived a decrease in mastery goal orientation across the transition to middle school also experienced a decline in self-efficacy beliefs (Friedel, Cortina, Turner, & Midgley, 2010).

Alspaugh (1998) investigated the link between the transition to middle school and achievement loss. The study followed a group of students who transitioned to a middle school in sixth grade and a group that remained in a Kindergarten to eighth grade (K-8) school. The study found a significant drop in standardized test scores for students transitioning to a new school in sixth grade, whereas no achievement loss was found for students remaining in a K-8 School (Alspaugh, 1998). This effect was greatest for students whose cohorts were separated and sent to different middle schools. When cohorts were sent to middle schools intact, a less significant drop in achievement was seen (Alspaugh, 1998). This drop in achievement followed the students to high school, where they again experienced an achievement drop during the transition. Students who transitioned to high school from a K-8 school experienced a less significant achievement loss (Alspaugh, 1998).

As suggested by Blackwell et al.'s (2007) model, a malleable belief may protect students from this dip in achievement during the middle school years. Again, research that will lead to a greater understanding of the motivational profiles of this age group, within the context of the Blackwell et al. (2007) model, could be useful in developing programs to help students navigate the transition to middle school successfully.

Necessary Next Steps in the Research

The current state of the research on STIs and Blackwell et al.'s (2007) model leaves many unanswered questions. These gaps in the research need to be addressed in order to understand the impact of STIs and the model with respect to student achievement motivation. The next steps in the research fall into five areas. First, research is needed to investigate where metacognition might fit into the model and to continue to demonstrate the interrelationships of the individual variables. As this has been previously discussed, the following section will focus more on the remaining four areas of necessary research. Second, more information is needed regarding how STIs develop and the factors that impact this development. Third, validation of Blackwell et al.'s (2007) and Jones et al.'s (2011) instrument is necessary to ensure the accurate measurement of this model and its variables. Fourth, more research is needed on the impact of the model with regard to low-income students and other groups susceptible to stereotype threat. Finally, after these questions have been answered, the research will be able to guide the development of effective psychosocial interventions, with the goal of increasing academic outcomes for students at-risk for stereotype threat, low achievement, and dropping out.

The development of STIs. One important question to consider in the study of STIs is where these self-theories originate from. There is research to suggest that one avenue through which children develop STIs is the feedback they receive on their performance (Dweck & Molden, 2005; Kamins & Dweck, 1999; Mueller & Dweck, 1998). Dweck & Molden (2005) argue that feedback that focuses on a student's individual traits will endorse an fixed view of ability, regardless of whether the feedback is positive or negative, therefore students who receive primarily trait-focused feedback will develop fixed views of intelligence (Dweck & Molden, 2005). Although positive praise for performance may have previously been viewed as a way to improve the student's self-esteem or self-efficacy, this may not be the case. Positive praise for performance may lead students to avoid situations where their success is not guaranteed (Elliot & Dweck, 1988). In 1998, Mueller and Dweck published a series of studies investigating the impact of praise on student motivation and performance. They found that students who received trait praise, or praise for their level of intelligence, expressed a desire to continue looking smart after completing a task. Students who received effort praise, on the other hand, expressed that they wanted to continue to learn new things (Mueller & Dweck, 1998). Effort praise also led participants to be more likely to persist in a task after failure, and to express task enjoyment after failure (Mueller & Dweck, 1998). The type of praise participants received also impacted the post-failure attributions the participants made. Effort praise led participants to attribute failure to a lack of effort, whereas intelligence praise led students to attribute failure to a lack of ability (Mueller & Dweck, 1998). Kamins and Dweck (1999) found similar results in a study involving kindergarten students. Participants who received intelligence praise were more likely to exhibit helpless behaviors after setbacks; they were also more likely to endorse the belief that "badness" could be assessed after one failure, and that this "badness" would remain stable over time. These results taken together suggest that the development of an individual's STI can be significantly impacted by the kinds of praise they receive over time.

Another aspect of STI development that has had some preliminary investigation is the direction of this development. In other words, do individuals tend to begin as fixed theorists and progress toward malleable views over time, or vice versa? There is some research to suggest that individuals move from a malleable view to a fixed view of intelligence over time (Ablard & Mills, 1996; Leondari & Gialamas, 2002). In a study of academically talented students ranging from 3rd to 11th grade, Ablard and Mills (1996) found that 37% of high school students, 34% of middle school students, and only 14% of elementary school students expressed an entity view. Conversely, 16% of high school students, 34% of middle school students, and 28% of elementary school students expressed a malleable view. In another cross-sectional study, Leondari and Gialamas (2002) also found that younger students were more likely to adopt a malleable view than older students. These findings may suggest that students move to an fixed theory over time – however, because these examples are not longitudinal studies, it is impossible to eliminate cohort traits as a cause for these differences. Gonida et al.'s (2006) study begins to address this issue. Fifth and sixth grade participants were tested twice, one year apart. This study found that over time, the students began to adopt more malleable views – contrary to their hypothesis (Gonida et al., 2006). Despite the fact that this is a fairly brief example of a longitudinal study, it does shed some light on the fact that cohort differences may be responsible for the previous findings. Jones, Byrd, and Lusk (2009) found similar results. In their study, a malleable view of intelligence was more prevalent in a sample of high school students. For a group of 142 ninth and eleventh grade students, 68.8% reported a malleable view of intelligence (M = 2.96, SD = 1.26, n = 141; Jones et al., 2009). Currently, there is some ambiguity in the research regarding whether individuals move towards a more malleable or fixed view over time. According to Nicholls (1978, 1990), students move through four levels of beliefs about effort and ability as they age. At level one, children view ability and effort as one and the same. Around age six, children give little consideration to ability with regard to outcomes, and instead view effort as the sole determinant. At about age nine, the individual begins to understand that ability and effort together impact academic outcomes. Finally, around age 12, the individual comes to view effort and ability as inverse covariates that impact academic outcomes. In other words, these students believe that a greater amount of effort indicates a lower level of ability. Inversely, when a task can be completed with a smaller degree of effort, this indicates a higher level of ability (Nicholls, 1978, 1990).

There is a lack of research on the overall development of students' STIs. Although some studies have quantitatively demonstrated the progression of STIs over time (Gonida et al., 2006), there is a lack of qualitative data detailing how students come to understand that their intelligence is either malleable or fixed. There is still little information on how these conceptions form and what factors influence their development the most. It is unclear whether these conceptions form mostly through interactions with parents, teachers, peers, or a combination of all three. There is also little information on the thought processes that have led students to their personal conceptions of intelligence. Qualitative research, in the form of in-depth interviews, would allow researchers to address this gap in the literature and gain a richer and more complex understanding of the development of STIs.

The process of developing successful interventions needs to be informed by research on the origination and development of students' STIs over time. If it is interactions with family or peer groups that largely impact STIs, then interventions that happen solely at school may not be as effective as they could be. If teachers' STIs impact students' self-theories, then it would be necessary to include teachers in the process of the intervention. There is also conflicting evidence on the direction of STI development. Do students move from a malleable view to a fixed view, or vice versa? It is possible that conflicting results have been found thus far because there is no universal movement from one view to the other as students age. More investigation is needed to determine if this is the case. With regard to measurement of STIs, there is conflicting qualitative data in relation to Dweck's inventory. The use of qualitative interviews to determine whether students' scores match their actual beliefs is necessary. Additional information is also needed regarding whether the two views are truly mutually exclusive.

Validation of Blackwell et al.'s (2007) instrument. As previously stated, there is currently a lack of information on the validity of the instrument currently being used to test this model of achievement motivation. Guided by Messick's (1995) six-part conception of validity, activities to ensure all six aspects of validity should be undertaken. To address content validity, expert opinion should be sought in reviewing the purpose of the instrument, the definitions of the construct, as well as the creation of the items. Construct definitions should also be reviewed after an extensive literature review has been completed. Expert opinion should include consultation with an expert in the field of motivation who has previously tested the model. For example, it could include consultation with an educator who has experience teaching this age group to ensure appropriateness of the test items. Issues of item technical quality will be addressed through item analysis, as well as consideration of previous findings using earlier versions of the instrument. Substantive validity has already been at least partially addressed through the theoretical framework that has been constructed in the development of this model and instrument. Further evidence for substantive validity may be offered through confirmation of the theoretical item hierarchy.

Structural validity for this instrument should be addressed through correlation analysis. Thus far, structural validity for earlier versions of the model is supported by correlational analysis. For each of the scales previously used, alpha scores are acceptable. For the two scales that are newly inserted into the instrument, previous uses, outside of testing this model, have also demonstrated acceptable alpha levels. Generalizability validity should be addressed by differential item functioning to test for item biases. This aspect of validity can also be addressed by administering the instrument with new populations. Issues of reliability should also be considered. With regard to consequential validity, scores should be interpreted as representative of the group as a whole – not as diagnostic of an individual's achievement motivation. When scores of this instrument are interpreted in this way, it removes the chance that students will be improperly diagnosed as having "low" motivation. External validity will be at least partially addressed by comparing the scores on this inventory to scores on previous versions. Using this method to thoroughly address the validity of the model will allow researchers to determine whether the current instrument is sufficient or requires substantial revisions.

The impact of interventions on low-income students. More attention should be paid to the potential impact of STIs and this model on the academic outcomes of low-income students. Students of a low socioeconomic status (SES) are at a significant disadvantage compared to their middle and high SES counterparts. Low-income students face a unique set of barriers in the academic setting, and are more likely to experience low academic achievement and eventually drop out of school (Berzin, 2010; Bradley & Corwyn, 2002; Battin-Pearson et al., 2000). These students are also more likely to experience difficulties in the transition to middle school, are vulnerable to stereotype threat, and are likely to express lower academic aspirations (Marjoribanks, 2003). These aspirations go on to have a significant impact on students' eventual educational attainment. Marjoribanks (2003) found that family background, individual characteristics, and proximal learning settings altogether impacted academic aspirations, and that these aspirations predicted educational achievement. The family background variable included information on students' family's levels of education, social status, and ethnicity. Students' social status was found to be significantly linked to educational attainment.

In a study of 11,154 low-income students in grades six through 12, Berzin (2010) also investigated which factors predicted academic aspirations. Students were asked whether they intended to go to college after graduation. Those who responded "yes" were considered to have high aspirations. Those responding "no," "don't know," or "do not think" were considered low-aspiration. Low-aspiration respondents reported significantly lower levels of school engagement and school satisfaction, and were more likely to report low academic achievement when compared to high-aspiration respondents (Berzin, 2010). Low-aspiration respondents reported lower levels of social support with respect to neighborhood, teacher, peer, and parent support (Berzin, 2010). This study illustrates the fact that, for low-income students, additional barriers such as low previous academic performance, disengagement from school, and low levels of support can impede educational aspirations, and ultimately attainment.

Poverty or low SES has also been linked to low academic achievement and an increased likelihood to drop out of high school (Battin-Pearson et al., 2000). In Battin-Pearson et al.'s (2000) study, the sample was comprised of 808 students followed from age 14 to age 16. Half of the sample was from low-income households (with a family income of $20,000 a year or less) and 52% participated in the free or reduced lunch program at school. Low SES at age 14 was found to be a significant direct predictor of low academic achievement and dropping out of high school before the end of 10th grade (Battin-Pearson et al., 2000). Low SES was also an indirect predictor for dropping out, mediated by low academic achievement. When considering all the variables included in the study, low academic achievement was the strongest predictor for dropping out. However, because low SES was found to be a direct predictor for dropping out, this means that low-income students who had not previously experienced low academic achievement were still at an increased risk for dropping out of high school before completing their tenth grade year (Battin-Pearson et al., 2000).

There is a body of research demonstrating that low SES may even impact cognitive development (Bradley & Corwyn, 2002; Duncan, Brooks-Gunn, & Klebanov, 1994; Kishiyama, Boyce, Jimenez, Perry, & Knight, 2008; Welsh, Nix, Blair, Bierman, & Nelson, 2009). Low SES children have been shown to perform poorer than high SES children in tests of working memory and verbal skills (Kishiyama et al., 2009). Although researchers agree that income level impacts academic achievement, there is still some debate as to exactly how (Bradley & Corwyn, 2002).

Stereotype threat and low-income students. In discussing the disadvantages faced by low-income students, it is necessary to discuss stereotype threat. It has been documented in previous research that stereotype threat contributes to the gender and race gaps in achievement (Aronson et al., 2002; Elizaga & Markman, 2008; Good et al., 2003). When students are reminded of their membership in a stereotyped group before undertaking an academic task, their performance is moderated by that stereotype (Good et al., 2003). Good et al. (2003) suggested that students in certain groups may experience negative performance outcomes because they are burdened by the prospect of confirming a negative stereotype.

In a series of studies of Black and White college students, Steele and Aronson (1995) had participants complete a difficult verbal test. Participants were assigned to a diagnostic condition, a non-diagnostic condition, and a challenge condition. Participants in the diagnostic condition were informed that the verbal test was a measure of intellectual ability. Those in the non-diagnostic condition were told that the test was a laboratory problem-solving task without a diagnostic element. Those in the third condition were told that they should view the difficult test as a challenge. The results showed that White students outperformed Black students in the diagnostic condition, but not in the non-diagnostic condition (Steele & Aronson, 1995). Additionally, Black students in the diagnostic condition completed fewer test items than their White counterparts (Steele & Aronson, 1995).

Elizaga and Markman (2008) found female college students' performance on a math task was impacted when stereotype awareness was activated before taking the task. The study was conducted to address the effects of stereotype threat on females in mathematics domains. Female participants were told that the math task was diagnostic or non-diagnostic of ability, depending on condition. Before taking the test, the participant interacted with a male or female student confederate who stated that he or she had either done well or done poorly on the test. Female participants in the diagnostic condition who interacted with a female that confirmed the stereotype answered fewer items correctly than participants in the non-diagnostic condition. Overall, participants who interacted with a confederate that confirmed the stereotype (a male who performed well, a female who performed poorly) answered fewer questions correctly in the diagnostic condition compared to the non-diagnostic condition.

Importantly, stereotype threat effects have also been found for low-income students (Desert, Preaux, & Jund, 2009; Harrison, Stevens, Monty, & Coakley, 2006; Regner, Huguet, &

Monteil, 2002). Regner et al. (2002) investigated the use of self-threatening stereotypes by low-income middle school students. In their first study, the researchers provided a group of middle school students with profiles of fictitious students' socioeconomic status. The students were then asked to infer what the fictitious students' performance would be on a memory test. The results showed that students who were low-income inferred performances that were consistent with the stereotype that low-income students perform poorly, while high-income students perform well (Regner et al., 2002). This was especially apparent for low-income students who were also low-achieving. In the second study, students were provided with profiles detailing the performance of a fictitious student and asked to infer the student's SES. The researchers found that high-income students did not make use of the low-income stereotype, whereas low-income students inferred an SES for their fictitious student that was consistent with the stereotype (Regner et al., 2002). The researchers suggest that high-income students may be reluctant to make use of such a stereotype, or that low-income students may be more aware of the stereotype because it applies to them (Regner et al., 2002).

Harrison et al. (2006) investigated the effects of stereotype threat for low-income college students. The participants were organized into diagnostic or non-diagnostic conditions and were given a 19-item mathematics test. The participants were also given scales to assess the effort they exerted on the task, their identification with mathematics, and their test anxiety. The researchers found that, for the non-diagnostic condition, high-income, middle-income and low-income students performed equitably (Harrison et al., 2006). For the diagnostic condition, high-income students performed significantly better than middle- or low-income students, and low-income students performed significantly worse than high- or middle-income students (Harrison et al., 2006). Harrison et al. (2006) also found that low-income students reported significantly higher test anxiety than middle- or high-income students for the diagnostic condition. In the non-diagnostic condition, test anxiety for low-income students was comparable to that of middle- or high-income students.

Desert et al. (2009) found similar results. First grade and third grade children were asked to perform Raven's progressive matrices. The participants were organized into diagnostic and non-diagnostic conditions and given a scale to measure stereotype endorsement. The researchers found that children as young as six years old are aware of and may endorse stereotypes about socioeconomic status (Desert et al., 2009). Consistent with previous findings, the low-income children in this study performed worse in the evaluative condition than they did in the non-evaluative condition (Desert et al., 2009). Finally, low-income children were found more likely to endorse the SES stereotype in the evaluative condition (Desert et al., 2009). Contrary to Harrison et al.'s (2006) findings, the researchers found that high-income participants endorsed SES stereotypes in both the evaluative and non-evaluative conditions.

To summarize, researchers have found that stereotype threat exists for low-income students, and that it can impact students' performance in evaluative or diagnostic conditions. Lower-achieving students are more likely to make use of self-threatening stereotypes, especially in evaluative conditions. Harrison et al. (2006) suggest that this may be a defense mechanism: endorsement of the SES stereotype may free the low-achieving student from personal responsibility for their performance. Finally, the research has demonstrated that children as young as six are aware of and are susceptible to SES stereotype threat. Recent work has shown that there may be methods to buffer students against stereotype threat, and this includes low-income students (Aronson et al., 2002; Good et al., 2003). As previously discussed, both Aronson et al. (2002) and Good et al. (2003) had success in reducing the effects of stereotype threat by encouraging a malleable view of intelligence in the participants. This is likely because a belief that intelligence is malleable leads the student to focus on the effort he or she puts forth, making stereotypes less relevant in predicting their personal outcomes on an academic task.

Development of metacognitive knowledge and skills may also protect low-income, low-achieving students from stereotype threat, as previous investigation has shown that metacognitive ability helps students who have an academic disadvantage (i.e., lower ability level, learning disability) perform on-par with more advantaged students (Swanson, 1990; Trainin & Swanson, 2005). Higher levels of metacognitive ability are also related to lower levels of anxiety in test taking situations, which is especially important for students who may experience the extra stress related to confirming or disconfirming stereotypes (Legg & Locker, 2009). For these reasons, both a malleable view of intelligence and higher metacognitive awareness and skills may prove to be important factors in helping low-income students avoid the impact of stereotype threat.

More information is needed to determine how a malleable view of intelligence may benefit disadvantaged or at-risk students. Good et al. (2003) and Aronson et al. (2002) have both demonstrated that a malleable view of intelligence may protect low-income and minority status students from stereotype threat. More information is needed to expand on these findings and answer new questions such as: Does a malleable view of intelligence protect students with learning disabilities against stereotype threat? What about other disadvantaged groups? Additionally, more research is necessary to understand what kinds of interventions would prove most beneficial for these groups. This type of research could address questions such as: Is a long-term intervention the only effective intervention? Would a short-term prime work for disadvantaged students?

Development of psychosocial interventions. Once the above gaps in the research have been addressed, researchers will have the strong theoretical foundation required to develop effective interventions. Testing the model with different populations will provide information on the appropriate invention approaches for different groups of students. Understanding the development of STIs will help researchers decide whether to include teachers' and parents' beliefs in the intervention design. As this information becomes available, pilot testing of interventions in different populations is necessary to continue to determine when these interventions are effective and appropriate.

Overall, five areas of necessary research have been presented: (1) further exploring and re-testing the model; (2) exploring the development of STIs; (3) validation of instrumentation; (4) more research on the impact of the model for low-income students or those at risk for stereotype threat; and (5) pilot testing of interventions with different populations. It is beyond the scope of this study to address each of these five areas. For this reason, this study will focus on the first area, further exploring and re-testing the model. Further research is needed to fully actualize this model and its many implications, but this research will focus solely on the first step in this series of steps.

Chapter 3: Methodology

Purpose and Research Questions

The purpose of this research was to explore and retest Blackwell et al.'s (2007) model in three significant ways: (1) by investigating the inclusion of a metacognition construct to the model, (2) by testing the model with a different population (rural middle school students), and (3) by testing the model within a different domain (the domain of science). The complete model, as I tested it, is shown in Figure 3. The following research questions guided the study:

1. To what extent are rural middle school students' self-theories of intelligence fixed or malleable in the domain of science?
2. To what extent do rural middle schools students have metacognitive knowledge and skills in the domain of science?
3. Does metacognition mediate the relationship between a malleable belief of intelligence and positive effort beliefs?
4. To what extent does the Blackwell et al. (2007) model fit data obtained from rural middle school students in the domain of science

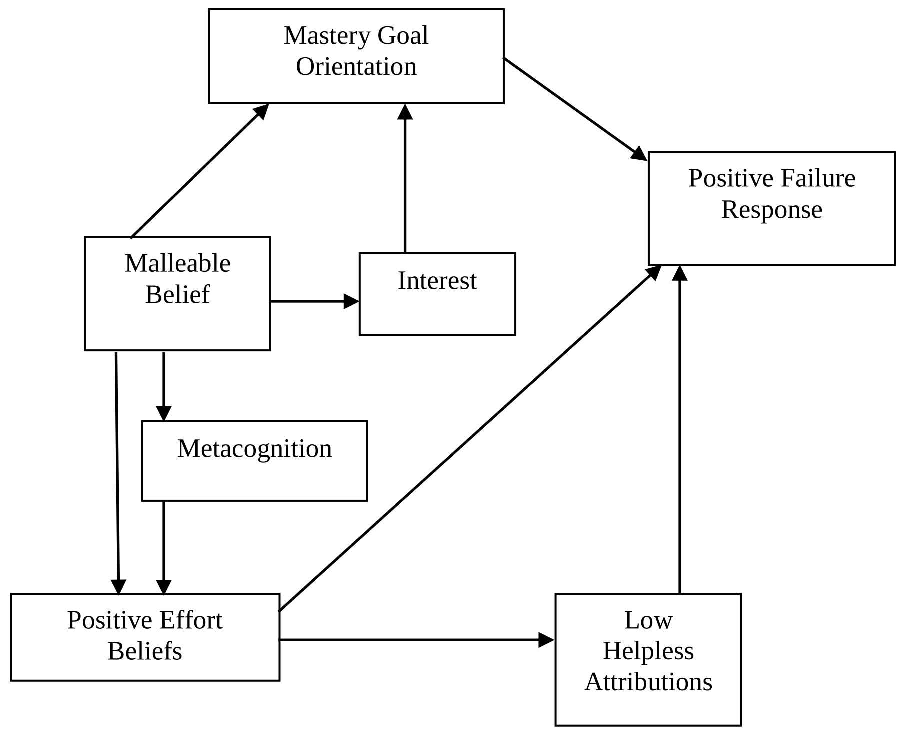

Figure 3. Theoretical model of the relationship of STIs to the seven motivational variables, as modified from Jones et al. (2011), Blackwell et al. (2007), and Dweck and Molden (2005).

Participants

Participants for this study were 385 sixth and seventh grade students from three schools (Schools 1, 2, and 3) in two counties (County A and County B) in Southwest Virginia. Of the 385 surveys received, only 367 were used. Eighteen surveys could not be used because there were large sections that were not filled out or the participants had included ratings on a six-point scale instead of a five-point scale on one or more items. Participants were from rural communities as defined by the 2000 Rural-Urban Commuting Area Codes, with a county-wide population in 2010 of 17,286 with 48.6 persons per square mile in County A and 29,235 with 63.3 persons per square mile in County B (U.S. Census Bureau, 2010). This is compared to an average of 202.6 persons per square mile for all of Virginia. Per capita income in County A in 2009 was $20,570, with 13% of the population living below the poverty line (U.S. Census Bureau, 2009). For County B, 14% of the population was reported living below the poverty line in 2009 (U.S. Census Bureau). Free and reduced lunch percentages for School 1 and School 2 (both in County A) were 46.6% and 44.7%; for School 3 in County B, 51.1% of students were approved for free or reduced lunches.

Demographics. Frequency statistics revealed that 46.3% of the respondents were from County B and 53.7% were from County A. Demographic information for respondents' gender, grade level, and race/ethnicity is presented below (see Table 2).

Table 2

Participant Demographics

	Frequency	Percent
Gender		
Female	194	52.9
Male	170	46.3
Grade Level		
Sixth	206	56.1
	161	43.9
Race/Ethnicity		
White or Caucasian		
	315	85.8
Black or African-American		
	14	3.8
Hispanic	3	0.8
Asian or Pacific Islander		
	6	1.6
American Indian	10	2.7
Bi- or Multi-racial	9	2.5
Other	9	2.5

Measures

The 49-item self-report questionnaire included scales that have been used previously and have undergone some preliminary validation. The scales for STIs, goal orientations, effort beliefs, causal attributions, and behavioral response after failure have been used previously by Blackwell et al. (2007) to test Dweck's motivational model and by Jones et al. (2011) to retest the model within the domain of mathematics. The interest subscale for this study was originally used by Jones et al. (2011). The scales selected to measure metacognition has not yet been used in this context of Dweck's motivational model.. Some scales have been modified in order to make them specific to the domain of science. All of the scale items are provided in the Appendix.

STIs. The *Implicit Theories of Intelligence Scale for Children – self form* (ITIS; Dweck, 2000), originally modified for use in this context by Jones et al. (2011) to address beliefs in mathematics, will be used to classify students as having either a malleable or fixed view of intelligence. These items will be modified to address the domain of science. This six-item scale includes three items assessing fixed view beliefs (e.g., "Your intelligence in science is something that you can't change very much.") and three malleable belief items (e.g., "You can always greatly change how intelligent you are in science."). Students will respond on a six-point Likert scale (1 = *strongly Agree*, 6 = *strongly disagree*). Fixed views items will be reverse-coded. Blackwell et al. (2007) reported a Cronbach's alpha of 0.78, with a test-retest reliability of 0.77 over a two-week period, and Jones et al. (2011) reported an alpha of 0.86.

Metacognition. The *Jr. MAI Version B* will be used to measure metacognitive knowledge and skills. This scale was derived from the original MAI, developed by Schraw and Dennison (1994), and as such it measures both components of the metacognition model.

Sperling et al. (2002) modified the instrument into two versions (*Versions A* and *B*) to create scales that were appropriate for use with elementary through high school students. This study will use *Version B*, an 18-item self-report inventory which was designed to be administered to students in grades six through nine, and has previously been administered in a rural, low-income setting (Sperling et al., 2002). Nine items address metacognitive skills, and nine items address metacognitive knowledge. Students are asked to use a 5-point Likert scale (1 = *never*, 5 = *always*) to report how often they engage in certain metacognitive behaviors during a learning task. The items on this scale are intended to measure general metacognitive knowledge and skills; therefore it was necessary to modify the 18 items to measure students' metacognition within the science domain. As an example, the item "I know what the teacher expects me to learn" was modified to "I know what the teacher expects me to learn in science." This small modification is a new use for this scale. Sperling et al. (2002) reported a Cronbach's alpha of 0.82. No significant differences between genders were found (t = .275, p > .05), although students in higher grades were found to score significantly higher than students in lower grades (F = 3.195, p < .05).

Goal orientation. Mastery goal orientation will be measured using the five items from the Personal Mastery Goal Orientation scale from the *Patterns of Adaptive Learning Survey* (Midgley, Maehr, Hruda, Anderman, Anderman, & Freeman, 2000). These items were originally used in this context by Blackwell et al. (2007), were revised by Jones et al. (2011) to be domain-specific for math, and will be modified here to be domain-specific for science. Students respond to the items using a six-point Likert scale (1 = *not at all true*; 6 = *very true*). Midgley et al. (2000) have reported a Cronbach's alpha of 0.85, and this scale has been previously shown to be a valid measure for mastery goal orientation. Jones et al. (2011) reported an alpha of 0.91.

Effort beliefs. Nine items will be used to measure effort beliefs. These items were originally used to test this model by Blackwell et al. (2007), taken from Sorich and Dweck (1996). These items were modified by Jones et al. (2011) to be domain specific for mathematics, and are modified here to address beliefs in science. A six-point Likert scale is applied to these items, ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Four items in the scale measure students' beliefs that effort is associated with positive outcomes, while the remaining five items measure students' belief that effort is inversely related to ability. Blackwell (2007) reported an alpha of 0.79 for the scale, and a test-retest reliability of 0.82 over a two-week period has been demonstrated (Blackwell et al., 2007). In addition, Jones et al. (2011) found a Cronbach's alpha of 0.77 for this scale.

Causal attributions. Four items will be used to measure causal attributions, originally used by Blackwell et al. (2007) and modified by Jones et al. (2011) to be domain specific for mathematics. These four items have been modified to assess beliefs in science. Students respond on a six-point Likert scale (1 = *not at all true*, 6 = *very true*) to a written scenario wherein the students imagine they have received an "F" on a science test. The items present four possible explanations for this failing grade ("I wasn't smart enough," "I'm just not good at science") and the students rate how true they feel these explanations would be for them. Blackwell (2002) reported an alpha of 0.76 for this scale, and Jones et al. (2011) reported an alpha of 0.64.

Behavioral response after failure. This five-item scale was also originally used by Blackwell et al. (2007) , modified by Jones et al. (2011) to assess beliefs in mathematics, and modified here to assess beliefs in science. These items are used as a follow-up to the scenario used to measure causal attributions, wherein students indicate what their behavior response would be after failing a science test, using the same six-point Likert scale used for the causal attributions scale. Blackwell (2002) reported an alpha of 0.84 for this scale, and Blackwell et al. (2007) reported a test-retest reliability measure of 0.71, over a two-week period. Additionally, Jones et al. (2011) reported a Cronbach's alpha of 0.76 for this scale.

Interest. The interest items for this instrument were taken from Jones et al. (2011) which were designed to be similar in content to those used by Eccles and Wigfield (1995), because their items have been documented as having excellent face, convergent, and discriminant validity, as well as strong psychometric properties (Eccles et al., 1983; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). The first item asked students about their interest in math ("In general, I find math to be very interesting.") and the second item asked them about how much they liked math ("I like math very much."). Students rated the items on a 6-point Likert-type scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Jones et al. (2011) found the reliability estimate for the instrument to be very high ($\alpha = .91$). These items were modified to be domain-specific to science.

Procedure

Pilot study. A pilot study of 12 students was conducted at one of the schools that participated in the study. The purpose of the pilot study was to determine how long it would take the students to complete the questionnaire and to identify potential problems with the wording of the questionnaire items. The students completed the questionnaire in 15 to 20 minutes, and only minor issues with item wording were discovered. The timing for data collection was tracked from the time the students entered the room until all but one of the students had finished. The second to last student finished the questionnaire in 15 minutes and 39 seconds. The last student required an extra five to seven minutes to complete the questionnaire. These students were chosen by their science teacher to represent a wide range of ability and achievement levels. Some students had difficulty understanding the term “Caucasian” in the demographic question, and one student inquired about the meaning of the word “seldom.” These terms remained in the instrument. It was determined that students asking about the word “seldom” would be told this word had the same meaning as “rarely.” For students asking about the work “Caucasian,” the researcher would point to its accompanying descriptor, “White.” Based on the pilot study, it was determined that students could complete the questionnaire items in 20 minutes or less and that it was reasonable to proceed with the primary data collection.

Primary data collection. The self-report instrument was administered to the School 1 and 2 (County A) students during a 30 minute period in each school’s cafeteria. Students were asked to sit on one side of the tables only, to encourage them to answer the items on their own. The researchers and a few school staff were present during the administration to answer students questions, encourage them to complete every item on the questionnaire, and to draw attention to the change in a Likert scale from six-point to five-point on one of the instruments. Students were encouraged to be as honest as possible. Because the principals at both School 1and 2 were interested in conducting a survey of students’ science beliefs for their own purposes, student consent forms were not required. Instead, the data from this study served the purposes of both the principals and the present research study.

In School 3 (County B), an opt-out form describing the study was sent home to parents. Consent was inferred for students not returning an opt-out form by the date of data collection. Parents were given two weeks to return the opt-out form. This method of obtaining consent was required by the school system in County B. The survey was administered by students' science teachers during their regular science period. Teachers were provided with a script that they were asked to read to the students before they began the questionnaire. An assembly during one science period prevented two seventh-grade classes from completing the instrument. As a result of the researcher not being present, a larger number of the returned questionnaires had a multiple missing responses or students rated items on a six-point scale instead of a five-point scale for some of the items. Treatment of these cases is described below in the section titled *Data Cleaning*. Administration of the questionnaire at all three schools took place during the fall of 2011 within the time span of a month.

Analysis

Component variables were created for each of the subscales in the instrument using the individual items, and these component variables were used to test the model. Individual items were used to compute descriptive statistics and Cronbach's alphas for the subscales. The criterion level for statistical significance (p) was set to 0.05.

To address the first research question, scores from the *Implicit Theories of Intelligence Scale for Children* were used to address the first research question. Fixed items were reverse-coded, and scores on the six items were averaged to provide an overall STI score for participants, with a score of (1) indicating a purely fixed view and a score of (6) indicating a purely malleable view. A mean score for all participants was to represent the STI for this sample of the population in the domain of science. A one-sample t-test was conducted to determine whether students in this sample tended toward a malleable or fixed view.

To address the second research question, scores from the *Jr. MAI Version B* were used. First, a confirmatory factor analysis was conducted to investigate how well the items loaded onto the bi-modal model of metacognition. These results will impact how metacognition is inserted into the structural model for research question four. Then, a mean score for the sample was calculated to determine whether these participants demonstrated metacognitive knowledge and skills that are above, below, or aligned with the cut-off score of 3.0 (the half-way point of the five-point Likert scale). The mean score will also be used to indicate whether students felt that in most instances they have metacognitive knowledge, and how often they felt they used their metacognitive skills. Mean scores will also be calculated for the knowledge and skills subscales, and these means will be compared. This will be done to examine the specific impact of metacognitive knowledge, a concept that has been neglected previously in this area of the research.

For the third research question, The *Implicit Theories of Intelligence Scale for Children*, the *Jr. MAI Version B*, and the effort beliefs scale (Blackwell et al., 2007; Jones et al., 2011) were used to test the mediating relationship of metacognition to STIs and effort beliefs. This analysis involved the use of Baron and Kenny's (1982) four steps. In the first step of this process, the initial variable (STIs) must be established as a significant predictor of the outcome variable (effort beliefs). Second, the initial variable (STIs) must be established as a significant predictor of the mediating variable (metacognition). Third, the mediating variable (metacognition) must be established as a significant predictor of the outcome variable (effort beliefs). All of these relationships were tested using linear regression. Fourth and finally, a Sobel test determines whether or not the relationship of STIs to metacognition to effort beliefs accounts for a significant amount of the relationship between STIs and effort beliefs. A p value of 0.05 or less was used as the criterion for significance in this analysis. Again, as a result of a lack of previous information on the effect of metacognitive knowledge in relation to STIs, the mediation analysis will be conducted two additional times using the metacognitive knowledge and metacognitive skill subscales in place of metacognition.

For the fourth research question, mediation analysis and structural equation modeling was used. Interest was retested as a mediator variable of STIs and goal orientation using Baron and Kenny's (1982) four steps. A significant Sobel test was used to indicate whether interest was a significant mediating variable. Next, structural equation modeling was used to test four variations of the achievement motivation mode. First, the model as it has been tested in the two previous studies (Blackwell et al., 2007; Jones et al., 2011) was be applied to the data to compare results. Second, metacognition was inserted into the model as a mediator variable between STIs and effort beliefs. Third, metacognitive knowledge replaced metacognition as a mediator variable for STIs and effort beliefs. Finally, the model was analyzed once more with metacognitive skill as the mediator variable between STIs and effort beliefs. Chi-square values were used as preliminary indicators of the model's fit to the data, with significant values suggesting poor fit. Several model fit indicators were used to gain more information about each model's fit to the data. For the normed fit index (NFI), a value above 0.90 was established as the cut-off for good fit (Bentler & Bonett, 1980). The goodness-of-fit index (GFI) and comparative fit index (CFI) were also used, with values closer to one considered to indicate better fit (Raykov & Marcoulides, 2006). The standardized root mean square residual (SRMR) was used, and it was determined that values below 0.05 would indicate good fit (Raykov & Marcoulides, 2006). The final fit indicator used was the root mean square error of approximation (RMSEA), and values between 0.01 and 0.08 were established as the range for adequate fit (Raykov & Marcoulides, 2006). The model fit indices were used to determine whether the model was an adequate fit for the data. The standardized path coefficients between the variables were used to examine the relationships between the variables and the significance of these relationships within the model. A p value of less than 0.05 was established as the criterion for a significant standardized path coefficient.

Chapter 4: Results

Data Screening

Only 10 missing cases were documented in the data. Missing cases were imputed using the mean of the individual's scores for the remaining items in the subscale. The data were cleaned for miskeys and responses outside of the appropriate Likert-format scale. These responses were addressed by returning to the raw data, which in most cases revealed a miskey by the researcher. One case revealed another six-point response in a five-point scale item, and this individual's questionnaire was removed from the study because it was possible that the individual used a six-point scale to answer the items instead of the five-point scale. Three missing cases were found for the gender item, as well as one missing case for the race/ethnicity item. Because the number of missing cases is small, and gender and race/ethnicity items are used primarily for demographic purposes in this study, these cases were not deleted from the data set. Skewness for the variables ranged from 0.235 to -0.797 and the kurtosis ranged from -0.913 to 0.275. All values for kurtosis were within an acceptable range (+ -1.0; George & Mallery, 2003).

Internal Consistency

Reliability of the subscales was explored using Cronbach's alpha values as a measure of internal consistency; the values are presented in Table 3. The values in the table illustrate that all subscales demonstrated acceptable levels of reliability, except for the STI subscale. When this subscale was divided into two separate scales, one for positively worded items, and one for negatively worded items that had been reverse-coded, Cronbach's alphas increased to 0.75 and 0.65, respectively. However, researchers have argued against using positive and negatively worded STI items on their own (Dweck et al., 1995; Dweck, 1999). Additionally, the subscale carries less meaning with regard to content without both positive and negatively worded items. In light of this, the decision was made to keep both positively and negatively worded, reverse-coded items together in the STI component variable.

Table 3

Reliability Estimates for Component Variables

Variable	α	*M*	*SD*
STI	0.58	3.99	0.84
Metacognition (M)	0.90	3.48	0.77
Effort Beliefs (EB)	0.66	4.22	0.81
Interest (INT)	0.84	3.74	1.49
Goal Orientation (GO)	0.89	3.76	1.00
Causal Attribution (CA)	0.73	4.24	1.30
Failure Response (FR)	0.75	4.81	1.10

Research Question 1

The first research question asked: To what extent are rural middle school students' self-theories of intelligence fixed or malleable in the domain of science? Scores from the ITIS were used to address the first research question. Items that indicated a fixed view of intelligence were reverse-coded, and scores on the six items were averaged to provide an overall STI score for participants. Thus, a higher score on the scale indicated a higher agreement with a malleable view of intelligence. A mean score for all participants was calculated to represent the STI for this participant pool in the domain of science. The mid-point value for the 6-point Likert-type scale was a 3.5; therefore, scores above 3.5 were considered to indicate a malleable view and scores below 3.5 were considered to indicate a fixed view of intelligence. Other researchers have also used the 3.5 value as a means to distinguish between fixed and malleable views (Dweck et al., 1995a; Jones et al., 2011). A one-sample *t-test* revealed that the overall mean score for STI (see Table 4) was significantly higher than the cut-off score for a malleable view of intelligence, 3.51 ($t = 11.01$; $p < 0.001$), indicating that the participants reported a significantly malleable view of intelligence. Table 4 shows that the means for STI by gender and grade level are very similar.

Table 4

STIs by School, Gender, and Grade Level

	M	*SE*
School		
1	4.19	0.07
2	4.12	0.09
3	3.81	0.07
Gender		
Female	3.94	0.06
Male	4.07	0.07
Grade Level		
Sixth	3.95	0.06
Seventh	4.06	0.06
	M	*SD*
Overall	3.99	0.84

Independent sample *t*-tests showed no significant differences between means for gender or grade level ($t = -1.496$, $p > 0.05$; $t = -1.065$, $p > 0.05$, respectively). A one-way ANOVA revealed significant differences for STI by school ($F = 8.639$, $p < 0.001$). Post-hoc tests revealed that students at School 3 reported lower mean values than School 1 (HSD = -0.312, $p < 0.05$) and School 2 (HSD = -3.89, $p < 0.001$). The post-hoc test showed no significant difference between the means of School 1 and School 2 (HSD = -0.077, $p > 0.05$). Thus, students at School 3 reported significantly less malleable views than students at School 1 and 2. A cutoff score of 3.51 was used to determine whether students' STIs were generally fixed or malleable. This value was chosen in accordance with previous usage of this subscale (Dweck et al., 1995; Jones et al., 2011). A score below 3.51 indicates a fixed view of intelligence, where a score above 3.51 indicates a malleable view of intelligence. A one-sample *t-test* revealed that the overall mean score for STI was statistically higher than the cut-off score for a malleable view of intelligence, 3.51 (t = 11.01; $p < 0.001$), indicating that the participants reported a significantly malleable view of intelligence.

Research Question 2

The second research question asked: To what extent do rural middle school students have metacognitive knowledge and skills in the domain of science? To address this question, scores from the *Jr. MAI Version B* were examined. First, a confirmatory factor analysis was run to investigate how well the items loaded onto the bi-modal model of metacognition. SPSS Amos 20 was used for this analysis, and metacognitive knowledge and metacognitive skill items were forced onto their respective factors. The maximum likelihood extraction method was used. A criterion level of 0.400 was used to determine significant factor loadings. Results showed that all but one of the items (item 47) loaded strongly onto their respective factors (see Table 5). Table 5 shows the standardized factor loadings for the metacognitive knowledge and the metacognitive skill items. Although the chi-square for the two-factor solution was significant, other fit indices suggested an adequate fit for the data (χ^2 = 447.09, df = 134, $p < 0.001$; NFI = 0.821, GFI = 0.850, CFI = 0.759, RMSEA = 0.08, SRMR = 0.067). Examination of the relationship between the two factors revealed a strong correlation (α = 0.91) for metacognitive knowledge and metacognitive skill. This shows that these two factors are so strongly correlated that they should not be treated as separate components within this study. Although the model fit indices and factor loadings suggest that this measure may reflect a bi-modal construct, this construct will be treated as one variable for the mediational and structural equation analyses as a result of this strong correlation value. For the structural equation analysis, metacognition will be treated as one unified observed variable, as opposed to a latent variable with two indicator variables. An investigation of means showed an overall mean of 3.48 for the respondents (for a five-point Likert scale). Means for metacognitive knowledge and skill were 3.77 and 3.19, respectively. A paired-samples *t*-test demonstrated a significant difference between the mean scores for metacognitive knowledge and skill ($t = 18.193$, $p < 0.001$). Although the creators of the MAI and *Jr. MAI* provide no cut-off scores for interpretation, a one-sample *t*-test demonstrated that the means for metacognitive knowledge and skill were both statistically higher than the mid-point of 3.0 for a five-point Likert scale ($t = 19.63$, $p < 0.001$; $t = 4.10$, $p < 0.001$, respectively). This suggests that students possessed a moderate amount of metacognitive knowledge and skills. An independent samples *t*-test revealed significant differences in mean scores for both metacognitive knowledge and skill by grade level (see Table 6).

The results in Tables 5 and 6 lend support to the dual-component, developmental conceptualization of metacognition. The model fit indices suggest that the two-factor solution is probably an adequate fit for the data. However, the strong correlation between the two components suggests that this relationship may not be as dichotomous as originally conceived; therefore, it is more appropriate to treat metacognition as one construct for the remainder of the analysis. The individual factor loadings generally support the two proposed components of metacognitive knowledge and metacognitive skill, although it is clear more validation work is required in this area. Table 6 illustrates the fact that seventh grade students had statistically more metacognitive knowledge and skills than their younger sixth grade counterparts, which supports the proposed developmental aspect of metacognition where knowledge and abilities in this area grow and improve with age.

Table 5

Individual Item Factor Loadings for Jr. MAI Version B

Item	Component	Standardized Factor Loading
56	MK	0.711
55	MK	0.670
45	MK	0.669
58	MK	0.572
43	MK	0.557
46	MK	0.556
44	MK	0.508
54	MK	0.432
47	MK	0.378
50	MS	0.719
49	MS	0.673
60	MS	0.670
51	MS	0.663
52	MS	0.659
53	MS	0.610
59	MS	0.607
57	MS	0.598
48	MS	0.513

Note. MK = metacognitive knowledge, MS = metacognitive skill

Table 6

Results for t-tests by Metacognition Component and Grade Level

Grade Level		*M*	*SD*	Mean Difference	*t*	*p*
MK	6	3.692	0.727	-0.1668	-2.123	<0.05
	7	3.859	0.763			
MS	6	3.111	0.908	-0.1836	-1.965	0.05
	7	3.295	0.872			

Note. MK = metacognitive knowledge, MS = metacognitive skill

Research Question 3

The third research question asked whether metacognition mediates the relationship between a malleable belief of intelligence and positive effort beliefs. The *ITIS*, the *Jr. MAI Version B,* and the effort beliefs scale (Blackwell et al., 2007; Jones et al., 2011) were used to test the mediating relationship of metacognition to STIs and effort beliefs (Baron & Kenny, 1986). In addressing research question 2, the results support the conception of metacognition as a bi-modal construct, comprised of both metacognitive knowledge and metacognitive skill. The aim for research question 3 was to determine the effect of metacognition as a cohesive whole with regard to STI and effort beliefs. However, since this relationship has previously been investigated by examining the impact of metacognitive skill or self-regulated learning alone, the impact of each component will also be examined here. For this reason, metacognition will first be treated as one over-arching construct comprised of two component pieces, and both the metacognitive knowledge and the metacognitive skills items will be used. The effect of each component will then be analyzed. Figure 4 shows the relationships that were tested. The first of Baron and Kenny's (1986) four steps involves demonstrating a relationship for path *c* (see Figure 4), between the initial variable (STI) and the outcome variable, effort beliefs (EB). A series of regression analyses were used to complete steps one through three (Dugard, Todman, & Staines, 2010). A linear regression analysis showed a significant relationship between STI and effort beliefs (B = 0.475, $\beta = 0.490$, $t = 10.75$, $p < 0.001$). According to these results, for every unit increase in STI, an increase of 0.475 units can be expected in effort beliefs. In other words, STI explains 47.5% of the variance in effort beliefs. The beta value shows that for every standard deviation increase in STI, an increase of 0.490 standard deviations can be expected for effort beliefs. Step two requires demonstrating the relationship along path *a* (see Figure 4) of the initial variable (STI) to the mediator variable, metacognition (M). Results demonstrated a significant relationship for STI and metacognition (B = 0.246, $\beta = 0.269$, $t = 5.33$, $p < 0.001$). In step three, the mediator variable (M) must be shown to impact the outcome variable (EB), which is shown in Figure 4 as path *b*. The regression analysis again showed a significant relationship for metacognition and effort beliefs (B = 0.471, $\beta = 0.444$, $t = 10.76$, $p < 0.001$). The fourth and final step of this analysis requires illustrating whether the effect of the initial variable on the outcome variable is significantly reduced when controlling for the mediator variable; whether the r^2 change of 0.12 found for this relationship is significant. As suggested by Baron and Kenny (1986), a Sobel test was used to complete step four and determine the significance of the mediating effect of metacognition on STI and effort beliefs. In other words, the Sobel test deduces whether the effect of the initial variable on the outcome variable is significantly reduced by the inclusion of the mediator variable. Using the unstandardized coefficients and standard errors from the regression analyses to conduct the Sobel test yielded a *z*-score of 4.78 ($SE = 0.02$, $p < 0.001$). These results suggest that metacognition significantly mediates the relationship between STIs and effort beliefs.

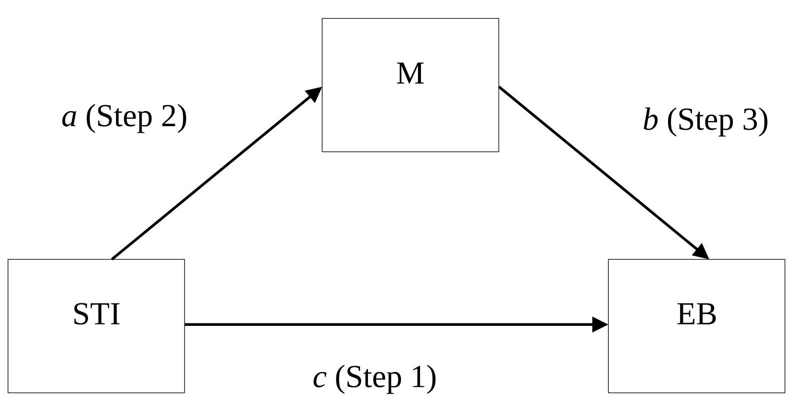

Figure 4. Paths Analyzed Using Baron and Kenny’s (1986) Four Steps - Metacognition

To investigate the individual effects of metacognitive skill (MS) and metacognitive knowledge (MK) as mediators of STI and effort beliefs, the four steps were repeated using the MS and MK subscales in place of the complete metacognition scale (M). For metacognitive skill, paths *c*, *a*, and *b* were found to be significant through regression analyses (B = 0.475, β = 0.490, t = 10.75, $p < 0.001$; B = 0.213, β = 0.200, t = 3.90, $p < 0.001$; B = 0.341, β = 0.376, t = 8.90, $p < 0.001$). The Sobel test revealed that metacognitive skill is a significant mediating variable for STI and effort beliefs (z = 3.56; *SE* = 0.02, $p < 0.001$). For metacognitive knowledge, paths *c*, *a*, and *b* were also found to be significant using linear regression (B = 0.475, β = 0.490, t = 10.75, $p < 0.001$; B = 0.277, β = 0.312, t = 6.27, $p < 0.001$; B = 0.500, β = 0.459, t = 11.02, $p < 0.001$). The Sobel test for this relationship revealed that metacognitive knowledge was a slightly stronger mediating variable for the relationship between STI and effort belief when compared to metacognitive skill alone or metacognitive knowledge and skill combined (z = 5.47, *SE* = 0.03, $p < 0.001$). This demonstrates this importance of including metacognitive knowledge, not just metacognitive skill, in examining the relationship of STIs to other motivational variables.

Research Question 4

The fourth research question asked: To what extend does the Blackwell et al. (2007) model fit data obtained from rural middle school students in the domain of science? To test the first part of the fourth research question, the mediating relationship of interest to STIs and mastery goal orientation (Baron & Kenny, 1986), the *ITIS*, the initial interest scale (Eccles & Wigfield, 1995), and the *PALS* Personal Mastery Goal Orientation scale were used (Blackwell et al., 2007; Jones et al., 2011). Baron and Kenny’s (1986) four steps were again followed to test this relationship. A series of three linear regression analyses satisfied steps one through three, demonstrating a significant relationship from the initial variable (STI) to the outcome variable (GO), from the initial variable (STI) to the mediating variable (INT), and from the mediating variable (INT) to the outcome variable (GO; see Figure 5). Paths *c*, *a*, and *b* (Figure 5) were found to be significant (B = 0.387, $\beta = 0.315$, $t = 6.35$, $p < 0.001$; B = 0.501, $\beta = 0.283$, t = 5.63, $p < 0.001$; B = 0.382, $\beta = 0.564$, $t = 13.24$, $p < 0.001$). Unstandardized coefficients and standard errors from these analyses were used to conduct the Sobel test, which yielded a *z*-score of 4.18 ($SE = 0.04$; $p < 0.001$). This indicates that interest significantly mediates the relationship of STIs and goal orientations for the data set.

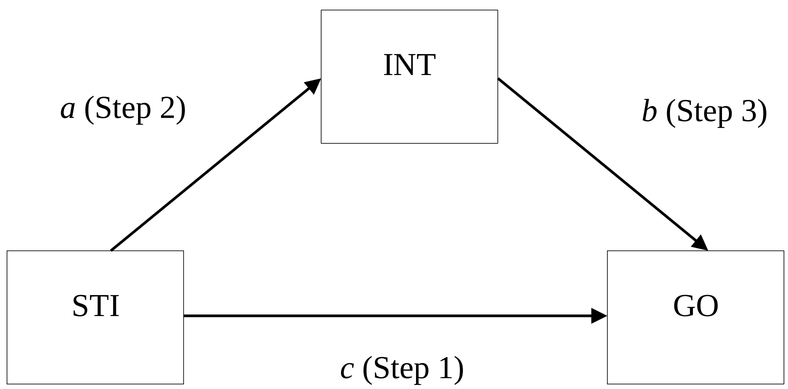

Figure 5. Paths Analyzed Using Baron and Kenny's Four Steps – Interest

Scores from all eight scales were used to answer the final part of the fourth research question. As previously mentioned, component variables were constructed using the individual items in each subscale. An analysis of Pearson correlations shows strong correlations between all seven of the model variables (see Table 7).

Table 7

Correlations for Model Variables

	1.	2.	3.	4.	5.	6.	7.
STI	--						
GO	0.315**	--					
EB	0.490**	0.560**	--				
M	0.269**	0.717**	0.544**	--			
INT	0.283**	0.608**	0.537**	0.541**	--		
CA	0.322**	0.412**	0.584**	0.377**	0.492**	--	
FR	0.233**	0.589**	0.504**	0.521**	0.474**	0.459**	--

Note. ** $p < .01$ *(2-tailed).*

Structural equation modeling was used to determine the goodness of fit of the proposed model to the data, and to determine the amount of variance explained by the model. According to Schumacker and Lomax (2010), a minimum of 100 to 150 subjects is required to conduct structural equation modeling, and a general rule of thumb holds that 10 to 20 subjects per variable provide a sufficient sample size. They also noted that, in a review of articles using SEM, most sample sizes ranged from 200 to 400 participants (Schumacker & Lomax, 2010). With seven variables in the model currently under consideration, the participant pool of 367 is more than adequate. Blackwell et al. (2007) and Jones et al. (2011) used similar participant pool sizes (373 and 163, respectively) to conduct similar analyses.

Initially, the data were fit to the model as it was tested by Jones et al. (2011; see Figure 6) to compare structure coefficients. This model successfully identified, indicating that a unique solution exists for all parameters in the model (Schumacker & Lomax, 2010). If unique solutions do not exist for the parameters in the model, it is argued that the parameters should not be estimated (Schumacker & Lomax, 2010). All paths in the model were found to be significant.

However, the chi-square value of 159.02 ($df = 7$, $p < 0.001$), suggested that this model is not a good fit for the data.

Model fit indices further suggest that this model may not be a sufficient fit to the data (NFI = 0.807; GFI = 0.894, CFI = 0.812, SRMR = 0.179, RMSEA = 0.244). According to Bentler and Bonett (1980), a NFI below 0.90 indicates poor fit. The goodness-of-fit index (GFI) varies between 0 and 1, with numbers closer to 1 indicating a well-fitting model (Raykov & Marcoulides, 2006). For the comparative fit index (CFI), values closer to 1 are likely to reflect a well-fitting model (Raykov & Marcoulides, 2006). The standardized root mean square residual (SRMR) is a standardized version of the RMR, where values below 0.05 indicate acceptable fit. For the RMSEA, values between 0.01 to 0.08 indicate excellent (0.01) to mediocre (0.08) fit (MacCallum, Browne, & Sugawara, 1996). Although the GFI and CFI suggest the model may have adequate fit, overall, these fit indices considered together suggest that this model may not be a good fit for these participants in the domain of science. See Figure 7 for a comparison of path values for the Blackwell et al. (2007) and Jones et al. (2011) studies with this study.

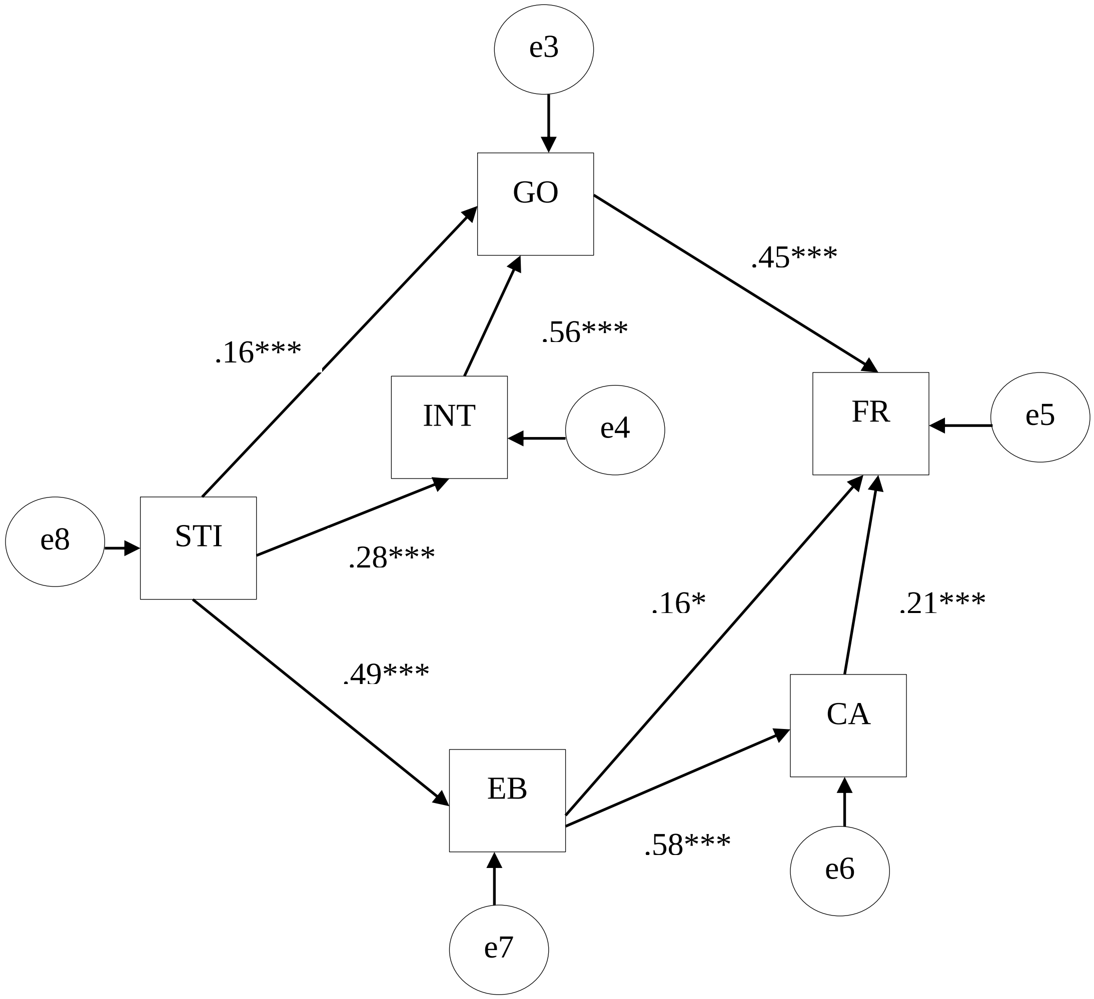

Figure 6. Structural model and standardized estimates from testing the Jones et al. (2011) model.
**** p <0.001, ** p <0.01, * p < 0.05*

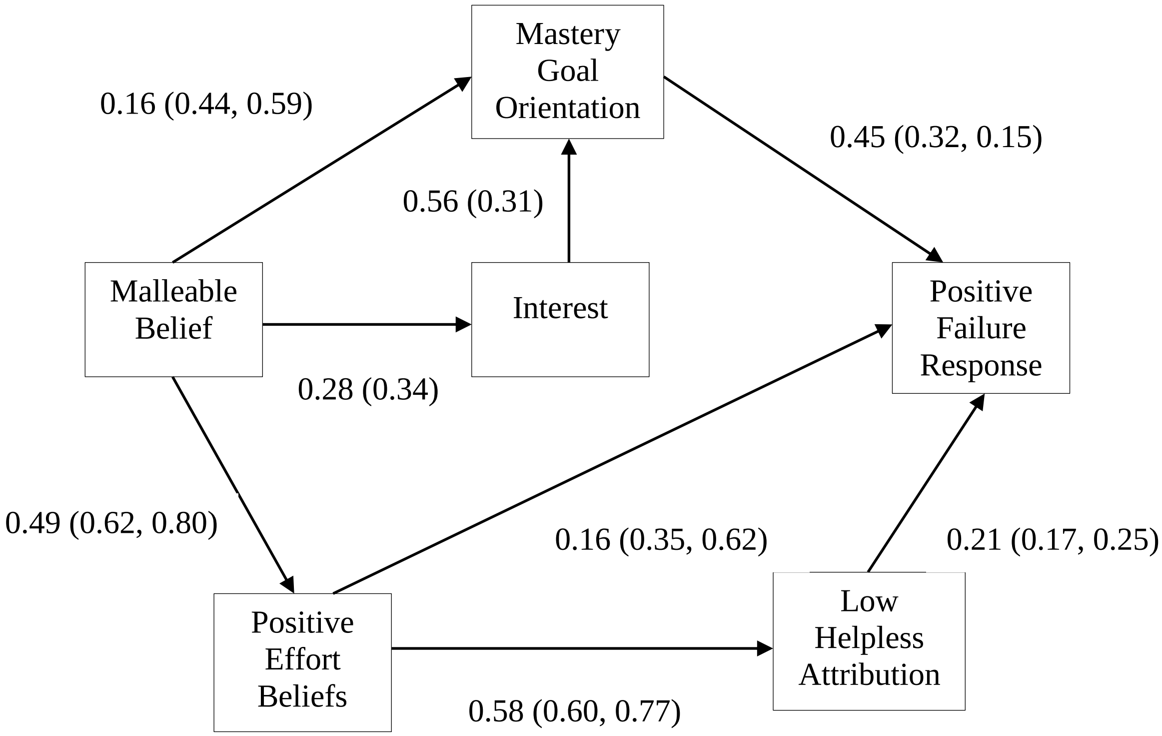

Figure 7. Comparative values for the Jones et al. (2011) model. Values outside parentheses are from this study. Values in parentheses are from Jones et al. (2011) and Blackwell et al. (2007), respectively.

To test the model with metacognition, metacognition was added as a variable between STI and effort beliefs. When testing this model, it was considered that the mediational analysis showed that metacognition as a complete construct (including metacognitive knowledge and metacognitive skill) was a significant mediator for STI and effort beliefs. Also, the confirmatory factor analysis for the metacognition items demonstrated a strong correlation between the two factors ($\alpha = 0.91$). Therefore, the model was initially tested to reflect metacognition as one construct, with metacognition treated within the model as one observed variable (see Figure 8). Again, all paths for the model were significant. However, the chi-square value for this model suggested a poor fit to the data ($\chi^2 = 328.46$, $df = 11$, $p < 0.001$). Fit indices generally supported this conclusion, with GFI again being the exception (NFI = 0.707, GFI = 0.845, CFI = 0.711, SRMR = 0.224, RMSEA = 0.281).

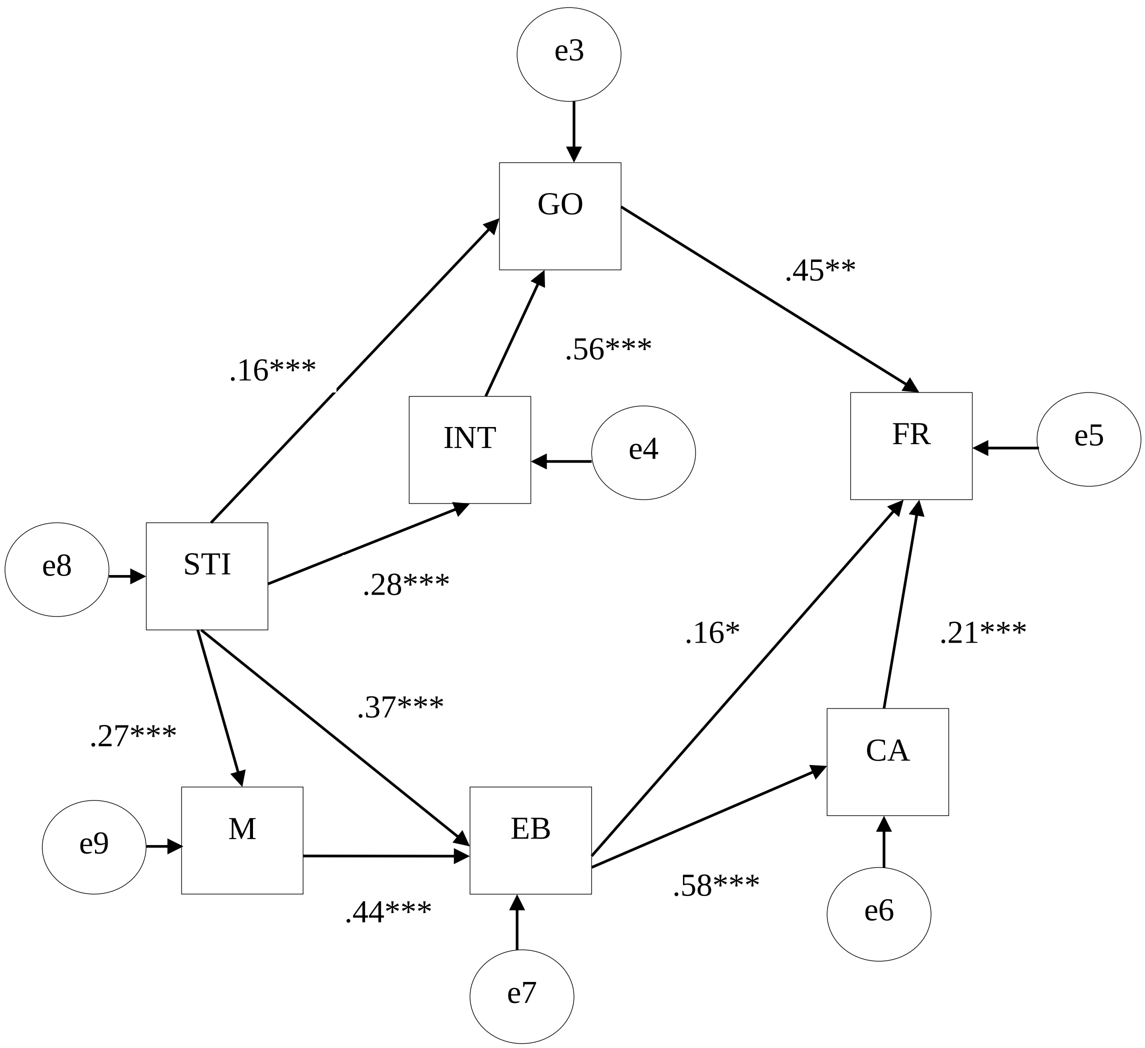

Figure 8. Structural model with metacognition observed variable . *** *p <0.001, ** p <0.01, * p < 0.05*

To fully explore the relationship of metacognitive knowledge and skills to the other motivational variables, two more variations of the model were run. Although metacognition was treated as an observed variable, as opposed to a latent variable with two component parts, it was decided to test the effect of each metacognition component individually. This was done because previous research has only examined the impact of metacognitive skill, neglecting the metacognitive knowledge component. First, metacognition (M) was replaced with the metacognitive knowledge subscale (MK; see Figure 9). As with the previous models, this model successfully identified. All paths in the model were significant, but the chi-square value for this model suggested a poor fit to the data ($\chi^2 = 306.49$, $df = 11$, $p < 0.001$). Model fit statistics were very similar to the previous model fit indices and supported the interpretation of the chi-square value (NFI = 0.724, GFI = 0.849, CFI = 0.729, SRMR = 0.218, RMSEA = 0.271), except for the GFI value, which suggests the model may have adequate fit.

Second, metacognition (M) was replaced with the metacognitive skill subscale (MS; see Figure 10). This model successfully identified, but again displayed an unsatisfactory chi-square ($\chi^2 = 293.10$, $df = 11$, $p < 0.001$). All paths were found to be significant. Model fit statistics showed that this model was a slightly better fit to the data, but was still a poor fit overall (NFI = 0.719, CFI = 0.724, SRMR = 0.215, RMSEA = 0.265). GFI was again the exception, indicating adequate fit (GFI = 0.857). Overall, all four models investigated here were found to be a less-than-satisfactory fit to the data.

It is worth noting that all of the paths in each of the above structural models were found to be significant, despite an overall lack of model fit. Even when all paths within a structural model are found to be significant, it is not guaranteed that the model will be a good fit for the data (Kenny, 2011). According to Bentler and Chou (1987): “Even when there are no problems with estimation, or unusual features to the results, a specified model may simply not fit the sample data” (p. 107). Thus, it is possible to have parameter values within expected ranges and still find that the proposed model does not fit the data. All of the models had a corresponding significant chi-square value, which given the current sample size, may be misleading. As sample size increases (above 200), the chi-square becomes more likely to indicate a significant probability level (Schumacker & Lomax, 2010). Another important aspect of the four above models is that they all show significant relationships between STI and metacognition, and metacognition and effort beliefs. This aligns with the mediation analysis revealing metacognition to be a significant mediator for STI and effort beliefs.

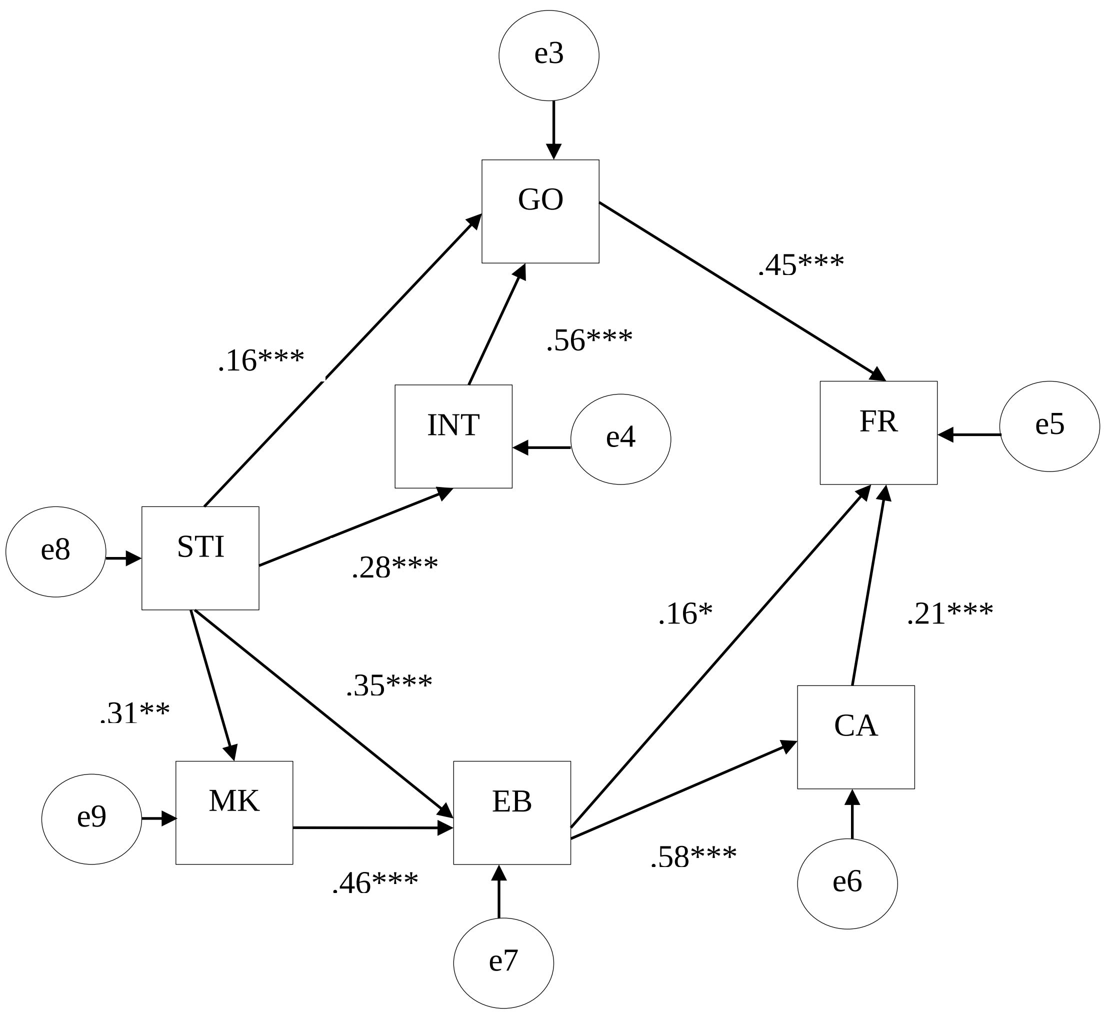

Figure 9. Structural model with metacognitive knowledge observed variable. *** *p <0.001, ** p <0.01, * p < 0.05*

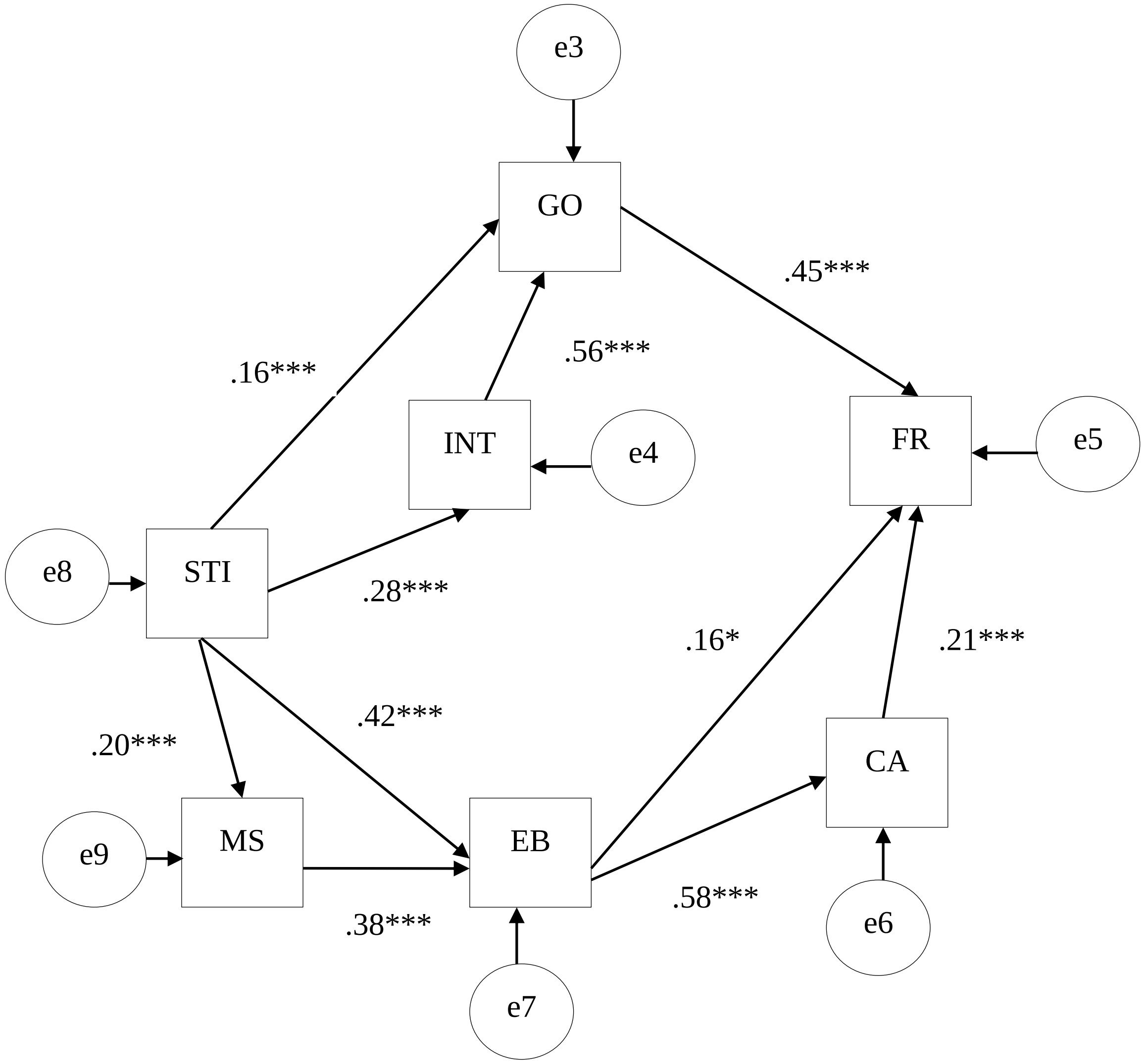

Figure 10. Structural model with metacognitive skill observed variable. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Chapter 5: Discussion and Conclusion

The overall goal of this research was to contribute to the theoretical and methodological work necessary for a complete and valid understanding of STI as a construct that impacts students' achievement motivation. This study used a self-report questionnaire to obtain this goal. This chapter will discuss the results of the previous statistical analyses in the context of the research questions of this study, describe the limitations of the current study, and present overall conclusions of the research. To maintain consistency with the previous chapter, the discussion of the results will be presented in four parts, with each part corresponding to a specific research question.

Research Question 1

In answering the first research question, *To what extent are rural middle school students' self-theories of intelligence fixed or malleable in the domain of science?,* results of the descriptive analysis and the independent- and one-sample *t*-tests showed that overall, students expressed a malleable view of intelligence that was significantly above the established cut-off value for a malleable view, with 63.8% expressing a malleable view of intelligence. No differences were found between the self-theories of the students by gender or grade level. In previous research testing STIs by age or grade level, it was hypothesized that students move from a malleable to a fixed view over time (Ablard & Mills, 1996; Leondari & Gialamas, 2002). Ablard and Mills (1996) found that only 34% of middle school students (sixth through eighth grade) expressed a malleable view of intelligence, indicating that a majority of students believed intelligence to be fixed. The current data do not support this finding given that the mean STI score for these middle school students was significantly above the cut-off for a malleable view of intelligence. These findings do, however, support the hypothesis that previous differential findings were the result of cohort differences in cross-sectional studies (Gonida et al., 2006;

Jones et al., 2009). Gonida et al. (2006) found that, in a short longitudinal study, which followed students from fifth and sixth grade to sixth and seventh grade (from 10 and 11 years old to 11 and 12 years old), students began to adopt more malleable views over time. Using a closed-ended item assessing whether participants felt that there was something students could do to increase their intelligence, Jones et al. (2009) also found that 87.7% of ninth- and eleventh-grade students expressed a malleable view of intelligence. Using the ITIS, the researchers found that 68.8% of students were classified as having a malleable view (Jones et al., 2009), similar to the 63.8% found in this study. It should be noted that previous work on the directionality of the development of STIs has looked at domain-general STI, whereas this study examined STIs in the domain of science, specifically. It is possible that STIs in differing domains will change, or remain stable, in different ways over time. The fact that there were no significant differences by grade level for this study suggests three things: first, that middle school students have not necessarily adopted a fixed view of intelligence; second, that longitudinal studies are necessary in order to properly address this question; and third, that more research is needed to determine the nature of students' STIs over time according to domain.

Despite a lack of difference by gender or grade, the one-way ANOVA and subsequent post-hoc test revealed significant differences by school. Students in School 3 had a mean STI score that was significantly lower than that of Schools 1 and 2. It is unclear as to exactly why this might be, although research discussed previously has suggested that the nature of the middle school transition can have an impact on motivation and learning outcomes (Alsphaugh, 1998; Anderman & Maehr, 1994; Anderman & Midgley, 1997; Chung et al., 1998). School 3 was a middle school was housed within a high school, whereas Schools 1 and 2 included elementary and middle school students in the same building. School 3 students would have transitioned out of the elementary school environment two years earlier than the School 1 and School 2 students, which may be a significant factor considering previous research that has shown that the timing of the middle school transition can impact learning outcomes. Alspaugh (1998) found that, as compared to students who remained in a K-8 school, students who transitioned in sixth grade experienced a significant drop in standardized test scores. Although this study focused on achievement and not motivational beliefs, previous research demonstrating a change in motivational beliefs in middle school (Anderman & Maehr, 1994; Anderman & Midgley, 1997; Chung et al., 1998; Friedel et al., 2010) suggests that an earlier transition to middle school may impact motivational beliefs in addition to achievement. Nonetheless, the overall STI means for all three schools indicated that students' beliefs about science intelligence was malleable.

Research Question 2

Related to the second research question, *To what extent do rural middle schools students have metacognitive knowledge and skills in the domain of science?*, aspects of the confirmatory factor analysis of the *Jr. MAI Version B* items demonstrated a strong fit for a two-factor solution, supporting the theoretical argument that metacognition is a bi-modal variable. In a validity analysis of the *Jr. MAI* (Sperling et al., 2002), an exploratory factor analysis of Version B revealed five factors. A forced two-factor solution accounted for 36% of the variance. The factor loadings and model fit indices in the present study also show support for a two-factor solution for the *Jr. MAI Version B*. Individual factor loadings for this study were similar to the loadings reported by These individual loadings differed from the previous study (Sperling et al., 2002) as a result of the analysis used; here, a confirmatory factor analysis was used as opposed to a forced two-factor exploratory factor analysis. As a result, no items were allowed to load onto both factors. Sperling et al. (2002) found that all but three metacognitive knowledge component items loaded onto one factor and all metacognitive skill items loaded onto one factor. In the present study, all but one item (a metacognitive knowledge item) demonstrated a high factor loading with the appropriate factor. The model fit indices revealed this model may be an adequate fit to the data (NFI = 0.821, GFI = 0.850, CFI = 0.759, RMSEA = 0.08, SRMR = 0.067). Contrary to these findings, however, the correlation between metacognitive knowledge and metacognitive skill was found to be very strong ($\alpha = 0.91$). This suggests that the items for metacognitive knowledge and metacognitive skill are not yet discriminant enough to consider them two completely separate components.

The analysis of the *Jr. MAI Version B* revealed that students felt they had more metacognitive knowledge in science than they had metacognitive skill in science. Thus, they felt they had more knowledge about learning in science, and themselves as learners in science, than they had or used skills to obtain their science learning goals. This domain-specific approach to examining metacognition is supported by other researchers (Sperling et al., 2002; Swanson, 1990) who suggested that, as students obtain more domain-specific knowledge, their metacognitive knowledge and skill may also begin to differentiate by domain. Students' scores on the *Jr. MAI Version B* were statistically higher than the mid-point scale value of 3.0. Although no guidelines for score interpretation are given for either the *Jr. MAI* or the original MAI, the mean score significantly higher than 3.0 suggests that these students expressed a moderate amount of metacognitive knowledge and skill. Scores are intended to be used to identify students for possible metacognitive interventions, and to assess change over time or as a result of interventions. Here, these results demonstrate that the students in the study reported metacognitive knowledge and skills that were not drastically above or below expectations. The difference found between metacognitive knowledge and metacognitive skill does highlight an area for possible improvement, which could be addressed by providing students with more opportunities to develop and practice their domain-specific metacognitive skills.

Also of importance, students' scores differed by grades, with seventh grade students reporting more metacognitive knowledge and skill in science than the sixth grade students. This is contrary to the findings in Sperling et al.'s (2002) validity analysis, in which none of the expected differences by grade were indicated by the data. This difference in results may be a result of research design: in the Sperling et al. (2002) study, scores on Version A were compared to Version B. Here, only scores for Version B were used to compare younger and older students. Further, this study focused on students' metacognitive beliefs within the domain of science, whereas the Sperling et al. (2002) study looked at domain-general metacognition. It is possible that students' metacognition in science develops differently than their general metacognitive knowledge and skills. The results for this study support Flavell's (1979) proposition that metacognition is a trait that is developed over time. The sixth grade students' significantly lower metacognitive knowledge and skills supports the idea that younger students tend to have less awareness of their cognition and less ability to monitor their own cognition in science, but this knowledge and ability expands as students mature (Flavell, 1979).

Research Question 3

Research question three asked: *Does metacognition mediate the relationship between a malleable belief of intelligence and positive effort beliefs?* The use of Baron and Kenny's (1986) four steps and the Sobel test demonstrated that metacognition, as a bi-model construct, was a significant mediator of STIs and positive effort beliefs. The two additional mediational analyses, determining the effects of metacognitive knowledge and metacognitive skill as mediators, showed that metacognitive knowledge in science was a slightly stronger mediating variable than metacognitive skill and metacognition overall. Considered in tandem with the results of the previous research question, it is possible that the result is related to the fact that students felt they had significantly more metacognitive knowledge than skill in science. If the students' overall confidence in their metacognitive skill was less than that of their metacognitive knowledge in science, it is possible that this concept would have less of an impact on how the students viewed effort.

Overall, the three mediational analyses supported the hypothesis that a malleable view of intelligence in science encourages students undertake the process of improving their intelligence, through which they improve their metacognitive knowledge and skills in science. Armed with improved metacognitive understanding, students come to view effort as the means through which they succeed. This supports Sungur's (2007) findings that the relationship between control of learning beliefs (the belief that ability to learn can be controlled) and effort regulation (the adjustment of effort after failure) was mediated by metacognitive strategy use. Sungur (2007) found a standardized path coefficient of 0.41 for the relationship between metacognitive strategy use and effort regulation. The present study found a similar result, with a standardized path coefficient of 0.47 between metacognition and effort beliefs. Here, this relationship initially investigated by Sungur (2007) is taken a step further, and metacognitive knowledge is established as a crucial part of this relationship within the domain of science.

Research Question 4

The final research question asked: *To what extent does the Blackwell et al. (2007) model fit data obtained from rural middle school students in the domain of science?* The model as it was previously tested and as it was modified here were a less-than-adequate fit for the data in the domain of science. As a means of comparison, it is useful to juxtapose the results of the present study to those of the Jones et al. (2011) study and the Blackwell et al. (2007) study. It is important to consider, however, that the Jones et al. (2011) study examined students' beliefs in the domain of mathematics and the Blackwell et al. (2007) study examined students' beliefs in a general manner, not specifying a particular domain.

The standardized path coefficients for the present study are generally smaller than those found in the previous two studies, with two exceptions: the path coefficient for mastery goal orientation and positive failure response, and the path coefficient for interest and mastery goal orientation (see Figure 7). The fit indices of the previous two studies revealed an adequate fit to the data. Jones et al. (2011) reported a chi-square of 26.3 ($p < 0.05$) and fit indices within acceptable ranges (CFI = 0.96, RMSEA = 0.10, PCLOSE = 0.04), with the RMSEA value indicating an excellent fit to the data. Blackwell et al. (2007) reported a chi-square of 606.22 ($p < 0.05$) and also found fit indices within acceptable ranges (CFI = 0.99, RMSEA = 0.068). Unlike the Jones et al. (2011) study, this RMSEA value demonstrates a poor fit. Overall, these numbers are quite different than the model fit values found for this study (NFI = 0.807; GFI = 0.894, CFI = 0.812, SRMR = 0.179, RMSEA = 0.244). These findings indicate that this model is not an adequate fit to the data. It is possible that students' achievement motivation in the domain of science differs from achievement motivation in math or in a domain-general context.

Figure 8 illustrates the results for the structural model with metacognition added as a mediating variable between STI and effort beliefs. Model fit values for this model were similar to the previous model (NFI = 0.707, GFI = 0.845, CFI = 0.711, SRMR = 0.224, RMSEA = 0.281). These results are also similar to the structural models testing metacognitive knowledge and metacognitive skill in place of metacognition (see Figures 9 and 10). In determining the overall fit for these four models, multiple fit indices were considered. One of the five fit indicators, the GFI, suggests that each of these four models may be an adequate fit for the data. However, the GFI is impacted by sample size, with larger sample sizes resulting in model fit where none exists (Schumacker & Lomax, 2010). The attributes of this fit index, taken into account with the four other indices indicating less-than-satisfactory or poor fit, suggests that this model is not an adequate fit to the data.

Contrary to the model fit findings, all of the individual paths of the four models were significant. Standardized path coefficients for the relationship between STI, metacognition, and effort beliefs supported the results from the mediational analysis, showing significant relationships between the three variables reflecting a mediating relationship. Schumacker and Lomax (2010) state the following three criteria in determining the statistical significance and substantive meaning of a structural model: (1) non-statistical significance of the chi-square test and the RMSEA, (2) statistical significance of individual parameter estimates of the model, and (3) the magnitude and direction of parameter estimates are within expected ranges. The model tested for this study, with metacognition included as a new variable (see Figure 8), satisfies the second and third criteria. The first criterion is not satisfied by this model. Thus, although all of the individual paths within the structural model were significant, the model is still not a meaningful representation of the data.

Three possible explanations for the lack of overall fit relate to the population, instrumentation, and domain. First, it is possible that the lack of fit comes from testing this model with a new population, and rural middle school students' experiences are significantly different enough from those of urban middle schoolers studied by Blackwell et al. (2007) that this model is not appropriate in understanding their motivational beliefs. Second, it is also possible that the problems with the instrumentation for this model are reflected in the lack of model fit. In the general analysis of the model subscales, the reliability estimates of the various subscales show that there are some issues with the instrumentation for this model. STI and effort beliefs subscales both demonstrated Cronbach's alphas that are satisfactory, but not very good. This suggests that these subscales may not be the most effective, valid, or reliable way to measure STIs or effort beliefs. Messick (1995) argued the importance of using an exploratory factor analysis to test the dimensionality on an instrument, and that this is a crucial step in establishing the validity of the instrument. This is reflected in Schumacker and Lomax's (2010) assertion that an EFA should be run testing the dimensionality of the measurement model in order to determine whether the theoretical model is supported by the factors within the data. The strong inter-subscale correlations (see Table 7) suggest that an EFA for the data may reveal unexpected factors not reflected in the theoretical model as it currently stands. The low Cronbach's alphas for some of the measures, particularly for the *Implicit Theories of Intelligence Subscale,* could also impact the estimates for the model. Validity and reliability of the instrumentation for this model need to be sufficiently addressed before fit of the model can be accurately assessed. According to Messick (1995), this would involve addressing the consequential, content, structural, substantive, external, and generalizability aspects of validity through a series of psychometric steps, including expert review, review of construct definitions, creation of a theoretical framework, correlation analysis and factor analyses, differential item functioning analysis, and the comparison of scores to similar external measures. As discussed previously in the literature review, some of these steps have already been completed for these instruments. However, dimensionality and differential item functioning still remain to be investigated for different students of different ages in different domains. Third and finally, it is also possible that these findings result from this study's focus on the domain of science.

Students' beliefs in the domain of science may differ significantly from motivational beliefs in the domain of math or in general. These differences would render this model an inappropriate representation of these students' beliefs. Overall, this model is a less-than-satisfactory representation of the data in the domain of science for middle school students given the model fit results and the apparent issues with the instrumentation.

Despite the lack of fit found with the data, the standardized path coefficients do provide useful information with regard to the individual relationships within the model. First, STI was found to be a significant predictor of interest, goal orientation, metacognition, and effort beliefs in science. These results aligned with the relationships proposed and researched by Dweck and Molden (2005), with regard to domain-general goal orientation and effort beliefs. Goal orientation, effort beliefs, and causal attributions were significant predictors of failure response in science. This also aligns with previous research on these relationships (Blackwell et al., 2007; Dweck & Molden, 2005; Jones et al., 2011), where students with a mastery goal orientation, positive effort beliefs, and low helpless attributions were more likely to try again after failure. Overall, students with a malleable view of intelligence in science were more likely to have a mastery goal orientation, higher levels of interest, higher levels of metacognition, and positive effort beliefs. This mastery goal orientation made the students more likely to try again after failing in a science task. Positive beliefs about effort made the students more likely to attribute failure to a lack of effort and try again after failing in a science task.

Implications and Future Research

Overall, these results suggest that rural middle school students express a malleable view of intelligence in science, and possess both metacognitive knowledge and skills in science at significantly different levels. This malleable view of intelligence in science is a resource that educators can capitalize on by nurturing through the appropriate kinds of praise and learning tasks. Learning tasks that allow and encourage students to try again until they have achieved mastery can also help in this goal. Nurturing this malleable view could make students more resilient to failure throughout the remainder of their educational careers.

The results also highlight the need for longitudinal studies of change in STIs related to age, and suggest that previous findings may have resulted from cohort differences, instead of development over time. Future research should investigate students' STIs beginning in third or fourth grade and follow them through the middle school and high school transitions in order to accurately investigate any change in STI.

The difference found between students' metacognitive knowledge and metacognitive skill also deserves attention. Finding a way to help students' metacognitive skills become more automated could involve using learning tasks that require certain strategies, with instructors focusing both on the content of the learning task and the method for completing it successfully. That students expressed a moderate to high amount of metacognitive knowledge suggests that they have the appropriate foundation, and are developmentally prepared, to expand on their metacognitive skills. The finding that metacognition is a mediating variable of STI and effort beliefs suggest that cultivating a malleable belief while also focusing on developing metacognitive skill may make both more successful, and ultimately encourage students to adopt positive effort beliefs.

Overall, the model (as it has been previously tested and as it was modified here) may not be the most valid conceptualization of students' achievement motivation. From a practical standpoint, within this study, the most useful information for the classroom comes from the mediational analyses, which suggest that interest and metacognition are important aspects of encouraging mastery goal orientations and positive effort beliefs, respectively. Focusing on gaining students' interest and helping them develop metacognitive knowledge and skills in specific topics or domains would seem to be able to help them improve their achievement motivation overall.

It is clear that more work remains to be conducted with regard to this motivational model in the domain of science. The measurement of STIs needs to be explored in greater detail, to determine whether the current method is the most valid possibility. This should include qualitative validation, as well as a qualitative exploration of the development of STIs. Semi-structured interviews should be used to ask students about their intelligence beliefs and what influences these beliefs. Specifically, these interviews should get the students' perspective on whether the primary influence for STI development comes from parents, teachers, or peers. It should also gain insight into how certain students are of their beliefs at different age levels. Responses in these interviews could be compared to the participants' responses on the ITIS, to see if there is adequate alignment between the scores on the instrument and participants' descriptions of their beliefs in their own words.

A thorough investigation of the validity of the subscales for this model is also necessary before it can be determined whether the poor model fit can be attributed to lack of valid measures or a need to re-examine the theoretical foundations of the model. Investigating the validity of the STI, effort belief, causal attribution, and failure response subscales is increasingly important as the need for effective ways to evaluate psychosocial interventions becomes more urgent (Yeager & Walton, 2011). The results of the present study suggest that more work is needed before it is appropriate to begin to use this model as a framework for constructing psychosocial interventions, or as a way to conceptualize student achievement motivation in the domain of science.

Limitations of the Study

There are several limitations that should be considered in the interpretation of the results of this study. The first relates to the instruments used to measure the constructs. The low Cronbach's alphas for several of the subscales limit the reliability of the current interpretations of these data. With larger subscales, it may have been possible to eliminate some of the lower performing items. However, because the subscales displaying improvable Cronbach's alphas included only four to six items, removing items would have been damaging to the content validity of the subscale. Future research in this area should focus on increasing the reliability for these subscales through differential item analysis and rewriting problematic items. Increasing the amount of items for each subscale would also be helpful; however, it is important to consider that this also increases the total number of items, which is already quite high for use with this age group. A thorough examination of the content validity would also address some of the validity issues present in this study, and should strive to determine whether these constructs are thoroughly defined and the items in the subscales fully represent the construct. Structural validity is also in question, as the correlation table (see Table 7) suggests that these variables, as they are currently being measured, may not be discrete, but instead overlap. Further examinations of dimensionality would address this issue.

It is particularly noteworthy that the measure for STI had the lowest alpha value (0.58). It is possible that this instrument is not acceptable for use in the domain of science. Because the instrument was developed to be domain general (and not refer to a specific subject area such as science), further validation for the use of this instrument within specific domains appears to be warranted. Research has suggested that STI may be domain-specific (Harackiewicz & Elliot, 1995). If this is the case, and students' STIs change depending on the context of the domain, then it becomes increasingly important to have valid measures of STIs within these domains.

Second, there were differences in data collection between the three school sites. Although the researchers were present for the data collection at two of the schools, the data was collected by the teachers at the other school. It is possible that at the school where the data was collected by the teachers without the researchers present that: some students might have finished too quickly to have truly read the items, some students might not have understood a specific item, or there were distractions present in the classroom at the time the questionnaire was completed. Having researchers present during all data collection or providing training for teachers in administering the questionnaire properly, would address this issue in the future. All students answered all of the same questions on the questionnaire; however, the sequence of the items differed for one of the schools. This difference in collection methods may have contributed to between-school differences. In addition, some of the items on the subscales were mixed together, instead of being presented in discrete sections. It is possible that, for the ITIS, where malleable and fixed items are both fairly compelling, presenting all six items together could keep students from providing contradictory responses by agreeing or strongly agreeing with all items. When the items are dispersed throughout the instrument, it is possible that the contradiction of agreeing with all the items is not as obvious to the respondents. Third, this study focused on the internal structure of the Jones et al. (2011) model; thus, a measure of achievement was not included. In order to make a more accurate and complete comparison between the results of this study and the Jones et al. (2011) and Blackwell et al. (2007) study, it will be necessary to include a measure of achievement in future investigations of this model in the domain of science.

There are also some issues with the manner in which achievement motivation was measured. This study relied solely on self-reported data, which assumed that the participants were able to accurately assess and report their beliefs. Previous research has demonstrated that self-report data can be problematic, and that respondents may not be adept at assessing themselves or may be dishonest in their responses (Kazemian & Farrington, 2005; Siegel, Aten, & Roghmann, 1998). In this instance, compelling items in the instrument that describe behaviors that a respondent strives for, but does not currently exhibit, may lead the respondent to give answers that are inaccurate descriptions of their current behavior. Future researchers could address this issue by administering the instrument while also having the participant talk about and explain their responses out loud. It also assumed that the participants would be accurate in analyzing beliefs which are often implicit, beliefs which they may not have thought about previously. Having students give more in-depth descriptions of their implicit beliefs, either verbally or through written responses, may begin to address this issue. However, it should be considered that having students examine their own motivational beliefs may inadvertently change those beliefs, as has been previously demonstrated for STIs (Quihuis et al., 2002). For this reason, researchers should have students explain their beliefs over the course of several different instances to allow for this development before making assessments of students' beliefs. Altogether, these factors relating to self-reported data limit the interpretation of the study's results.

It is beyond the scope of this study to address more than the preliminary, foundational steps in the series of necessary steps described in this dissertation to explore the Jones et al.

(2011) model, investigate the development of STIs, firmly establish the validity of this model, its usefulness in guiding the development of interventions, and the overall effectiveness of STI interventions. It should also be noted that, as a preliminary step in filling research gaps on this topic, this analysis investigates statistical, not behavioral, relationships. Although this provides necessary information, future research should seek to investigate these relationships in terms of actual behaviors in students. This would be an important step forward in establishing the content validity of this model and its instrumentation. Accomplishing this task would involve a combination of quantitative and qualitative measures. Having students keep journals of their motivational beliefs and metacognitive behaviors on a daily basis would provide a window into actual behaviors, as would comparing this information to students' grades and reports from teachers, peers, and parents. Researcher observations of students as they complete learning tasks would also be an important facet of such an investigation, where students would describe their chosen approaches and their beliefs as they go through the process of completing the task.

Conclusion

This results of this research demonstrated that rural middle school students expressed a malleable theory of science intelligence that was statistically above the established cut-off score for malleability. Students in this study also reported that they possessed a moderate amount of both metacognitive knowledge and skills in the domain of science, but that they have significantly more metacognitive knowledge than skills. For these students, metacognition was shown to be a mediator between STI and effort beliefs. Students who had a malleable view were more likely to have higher metacognitive knowledge and skills, and were thus more likely to have positive effort beliefs. Although the Blackwell et al. (2007) model was not found to be a good fit, the standardized path coefficients in the model supported the mediational analysis, demonstrating further evidence that metacognition, influenced by STIs, plays an important role in the development of positive effort beliefs. The standardized path coefficients also supported research previously discussed by Dweck and Molden (2005). Specifically, STI was found to be a significant predictor of interest, goal orientation, metacognition, and effort beliefs. This suggests that a malleable belief plays an important role in the way that students develop a desire to learn for the sake of learning, and in how they come to believe that exerting effort leads to success. Mastery goal orientation, positive effort beliefs, and low helpless attributions led students to be more likely to try again after failure in science. This positive failure response has been linked to positive academic outcomes (Blackwell et al., 2007; Dweck & Molden, 2005), which suggests that these functional achievement motivation beliefs would have a positive impact on the students' academic outcomes in the domain of science.

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Appendix A

Motivational Model Instrument

1. Self-Theories of Intelligence: Implicit Theories of Intelligence Scale for Children – self form (From Jones et al., 2011)

6-point Likert scale (1=Strongly Agree; 2=Agree; 3=Somewhat Agree; 4=Somewhat Disagree; 5=Disagree; 6=Strongly Disagree); reverse-code incremental items

1. Your intelligence in science is something that you can't change very much.
2. You have a certain amount of intelligence in science, and you really can't do much to change it.
3. You can learn new things, but you can't really change your basic intelligence in science.
4. No matter who you are, you can change your intelligence in science a lot.
5. You can always greatly change how intelligent you are in science.
6. No matter how much intelligence you have in science, you can always change it a good amount.

2. Metacognition: Junior MAI Version B [Adjusted for science domain]

5-point Likert scale (1=Never; 2=Seldom; 3=Sometimes; 4=Often; 5=Always)

1. I know when I understand something in *science.* (Knowledge)
2. I can make myself learn *in science* when I need to. (Knowledge)
3. I try to use ways of studying that have worked for me before *in science.* (Knowledge)
4. *In science,* I know what the teacher expects me to learn. (Knowledge)
5. I learn best when I already know something about the topic *in science.* (Knowledge)
6. I draw pictures or diagrams to help me understand while learning *science.* (Skills)
7. *In science* when I am done with my work, I ask myself if I learned what I wanted to learn. (Skills)
8. I think of several ways to solve a *science* problem and then choose the best one. (Skills)
9. I think about what I need to learn *in science* before I start working. (Skills)
10. *In science,* I ask myself how well I am doing while I am learning something new. (Skills)
11. I really pay attention to important information *in science.* (Skills)
12. *In science,* I learn more when I am interested in the topic. (Knowledge)
13. I use my learning strengths to make up for my weaknesses *in science.* (Knowledge)
14. *In science*, I use different learning strategies depending on the task. (Knowledge)
15. I occasionally check to make sure I'll get my *science* work done on time. (Skills)
16. I sometimes use learning strategies *in science* without thinking. (Knowledge)
17. I ask myself if there was an easier way to do things after I finish a *science* task. (Skills)
18. *In science,* I decide what I need to get done before I start a task. (Skills)

3. Goal Orientation: Patterns of Adaptive Learning Survey, Personal Mastery Goal Orientation (Revised) Midgley et al. (2000), From Jones et al. 2011

5-point Likert scale (1=not at all true; 5=very true)

1. It's important to me that I learn a lot of new science concepts this year.
2. One of my goals in science class is to learn as much as I can.
3. One of my goals is to master a lot of new science skills this year.

4. It’s important to me that I thoroughly understand my science class work.
5. It’s important to me that I improve my science skills this year.

4. Effort Beliefs: 9-Items from Blackwell (2002), taken from Sorich & Dweck (1996), modified

6-point Likert scale (1=strongly disagree; 6=strongly agree)

1. To tell the truth, when I work hard at science, it makes me feel like I’m not very smart.
2. It doesn’t matter how hard you work, if you’re not smart in science, you won’t do well in it.
3. If you’re not good at science, working hard won’t make you good at it
4. If science is hard for someone, it means that he or she probably won’t be able to do really well at it.
5. If you’re not doing well at science, it’s better to try something easier.
6. When science is hard, it just makes me want to work more on it, not less.
7. If you don’t work hard at science and put in a lot of effort, you probably won’t do well.
8. The harder you work at science, the better you will be at it.
9. If a science assignment is hard, it means I’ll probably learn a lot doing it.

5. Causal Attributions: Helpless Attributions and Responses from Blackwell et al. (2007).

6-point Likert scale (1=not at all true, 6=very true), students respond to a written scenario:

When you read the following story, pretend that it really happened to you and try to picture how you would feel and what you would do if it happened.

You start a new science class at the beginning of the year and you really like science and the science teacher. You think you know science pretty well, so you study a medium amount for the first quiz. After the quiz, you think you did okay, even though there were some questions you didn’t know the answer for. Then the class gets their quizzes back and you find out your score: you only got a 54, and that’s an F.

What would you think was the main reason why you failed the quiz? The reason why I failed the quiz was that…

1. I wasn’t smart enough.
2. the test was unfair, too hard for the class.
3. I’m just not good at science.
4. I didn’t really like science that much.

6. Behavioral Response after Failure

(Continued from Causal Attributions scale)

What do you think you would do next?

1. I would work harder in science class from now on.
2. I would spend more time studying for science tests.
3. I would try not to take science ever again.
4. I would spend less time on science from now on.
5. I would try to cheat on the next science test.

7. Interest: Interest Scale taken from Jones et al. (2011), (α = .91)

6-point Likert scale (1=Strongly Disagree; 6=Strongly Agree)

1. In general, I find science to be very interesting.
2. I like science very much.

Appendix B

County A Questionnaire

Science Questionnaire

Directions

This is not a test and there are no right or wrong answers. We are only interested in your honest opinion. Your responses will remain confidential. This means that no one at your school will know how your answered these questions because your names will be removed from the questionnaire and your answers will be summarized with the answers of the other students in your school.

Some of the questions will seem similar to one another; however, it is important that you answer all of them to ensure that we completely understand your answers.

The questions ask you to select a number for your answer. Please select the number that best describes what you believe.

Example Question 1

Please select one of the numbers from 1 to 6 below and write it in the space next to the question.

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

_______ 1. I like to eat pizza.

Example Question 2

Please circle one of the numbers from 1 to 6 below.

How much do you like pizza?

1	2	3	4	5	6
A Little					A Lot

For these questions, you would select a “6” if you like to eat pizza a lot, you would select a “1” if you do not like pizza at all, or any number in between depending on how much you like pizza.

Be careful, because some questions only ask you to answer between 1 and 5, not 1 and 6.

Science Questionnaire

Name (print): ______________________________________

Part 1 Directions

Please select one of the numbers from 1 to 6 below and write it in the space next to each question.

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

_______ 1. Doing well in science is very important to me.

_______ 2. If a science assignment is hard, it means I'll probably learn a lot doing it.

_______ 3. In general, I find science to be very interesting.

_______ 4. I do my science homework all the time.

_______ 5. Your science intelligence is something about you that you can't change very much.

_______ 6. Scientists spend most of their time working by themselves.

_______ 7. If you're not doing well at science, it's better to try something easier.

_______ 8. My future career will involve science.

_______ 9. I would like to take more science courses in the future.

_______ 10. I really pay attention in science class.

_______ 11. Success in science is very valuable to me.

_______ 12. I try very hard in science class.

_______ 13. I try to learn about science topics outside of school time.

_______ 14. If science is hard for someone, it means that he or she probably won't be able to do really well at it.

_______ 15. When I study for science, I put forth my best effort.

_______ 16. You have a certain amount of intelligence in science, and you really can't do much to change it.

Part 2 Directions

Please circle one of the numbers from 1 to 6 below.

17. How good at science are you?

1	2	3	4	5	6
Not at all Good					Very Good

18. If you were to list all of the students in your class from worst to best in science, where would you put yourself?

1	2	3	4	5	6
One of the Worst					One of the Best

19. How have you been doing in science this year?

1	2	3	4	5	6
Very Poorly					Very Well

Part 3 Directions

Please select one of the numbers from 1 to 6 below and write it in the space next to each question.

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

_______ 20. The harder you work at science, the better you will be at it.

_______ 21. I believe that science topics are important for my future.

_______ 22. You can learn new things, but you can't really change your basic intelligence in science.

_______ 23. You can always greatly change how intelligent you are in science.

_______ 24. I put a lot of effort into my science class.

_______ 25. Being good at science is an important part of who I am.

_______ 26. No matter how much intelligence you have in science, you can always change it a good amount.

_______ 27. To tell the truth, when I work hard at science, it makes me feel like I'm not very smart.

_______ 28. In the future, I will have a career that requires me to understand science.

_______ 29. It doesn't matter how hard you work – if you're not smart in science, you won't do well in it.

_______ 30. It matters to me how well I do in science.

_______ 31. If you're not good at science, working hard won't make you good at it.

_______ 32. No matter who you are, you can change your intelligence in science a lot.

_______ 33. When science is hard, it just makes me want to work more on it, not less.

_______ 34. In general, science is useful to me.

_______ 35. If you don't work hard at science and put in a lot of effort, you probably won't do well.

Part 4 Directions

Please select one of the numbers from 1 to 6 below and write it in the space next to each question.

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

_______ 36. It is important to me to do well in science class.

_______ 37. I like science very much.

_______ 38. I put a lot of energy into science class.

_______ 39. Scientists have a chance to make a difference in the world.

_______ 40. What I learn in science applies to my life.

_______ 41. Scientists help people.

_______ 42. I plan on attending college.

Part 5 Directions

Note that the scale has changed to a 1 to 5 scale.

1	2	3	4	5
Never	Seldom	Sometimes	Often	Always

_______ 43. I know when I understand something in science.

_______ 44. I can make myself learn in science when I need to.

_______ 45. I try to use ways of studying that have worked for me before in science.

_______ 46. In science, I know what the teacher expects me to learn.
_______ 47. I learn best when I already know something about the topic in science.
_______ 48. I draw pictures or diagrams to help me understand while learning science.
_______ 49. In science when I am done with my work, I ask myself if I learned what I wanted to learn.

_______ 50. I think of several ways to solve a science problem and then choose the best one.
_______ 51. I think about what I need to learn in science before I start working.
_______ 52. In science, I ask myself how well I am doing while I am learning something new.
_______ 53. I really pay attention to important information in science.
_______ 54. In science, I learn more when I am interested in the topic.
_______ 55. I use my learning strengths to make up for my weaknesses in science.

_______ 56. In science, I use different learning strategies depending on the task.
_______ 57. I occasionally check to make sure I'll get my science work done on time.
_______ 58. I sometimes use learning strategies in science without thinking.
_______ 59. I ask myself if there was an easier way to do things after I finish a science task.
_______ 60. In science, I decide what I need to get done before I start a task.

Part 6 Directions

Note that the scale is from 1 to 5.

1	2	3	4	5
not at all true		somewhat true		very true

_______ 61. It's important to me that I learn a lot of new science concepts this year.

_______ 62. One of my goals in science class is to learn as much as I can.

_______ 63. One of my goals is to master a lot of new science skills this year.

_______ 64. It's important to me that I thoroughly understand my science class work.

_______ 65. It's important to me that I improve my science skills this year.

Part 7 Directions

When you read the following story, pretend that it really happened to you and try to picture how you would feel and what you would do if it happened.

You start a new science class at the beginning of the year and you really like science and the science teacher. You think you know science pretty well, so you study a medium amount for the first quiz. After the quiz, you think you did okay, even though there were some questions you didn't know the answer for. Then the class gets their quizzes back and you find out your score: you only got a 54, and that's an F.

What would you think was the main reason why you failed the quiz? The reason why I failed the quiz was that…

1	2	3	4	5	6
Not at all true					Very true

_______ 66. I wasn't smart enough.

_______ 67. the test was unfair, too hard for the class.

_______ 68. I'm just not good at science.

_______ 69. I didn't really like science that much.

What do you think that you would do next?

1	2	3	4	5	6
Not at all true					Very true

_______ 70. I would work harder in science class from now on.

_______ 71. I would spend more time studying for science tests.

_______ 72. I would try not to take science ever again.

_______ 73. I would spend less time on science from now on.

_______ 74. I would try to cheat on the next science test.

Part 8

75. Your Gender: *(circle one)*

1. Female	2. Male

76. Your Race: *(circle one)*

1. White	2. Black or African-American	3. Hispanic	4. Asian or Pacific Islander	5. American Indian	6. Other

77. Your Grade Level: *(circle one)*

5^{th} grade	6^{th} grade	7^{th} grade

78. What is your BEST estimate as to your current grade in your SCIENCE class this year: *(circle one)*

A+	**A**	**A-**	**B+**	**B**	**B-**	**C+**	**C**	**C-**	**Below C**

Appendix C

County B Questionnaire

VirginiaTech Science Questionnaire

Directions

This is not a test and there are no right or wrong answers. We are only interested in your honest opinion. Your responses will remain confidential. This means that no one at your school will know how your answered these questions because your names will be removed from the questionnaire and your answers will be summarized with the answers of the other students in your school.

Some of the questions will seem similar to one another; however, it is important that you answer all of them to ensure that we completely understand your answers.

The questions ask you to select a number for your answer. Please select the number that best describes what you believe.

Example Question 1

Please select one of the numbers from 1 to 6 below and write it in the space next to the question.

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

_______ 1. I like to eat pizza.

Example Question 2

Please circle one of the numbers from 1 to 6 below.

How much do you like pizza?

1	2	3	4	5	6
A Little					A Lot

For these questions, you would select a “6” if you like to eat pizza a lot, you would select a “1” if you do not like pizza at all, or any number in between depending on how much you like pizza.

VirginiaTech Science Questionnaire

Part 1 Directions

Please select one of the numbers from 1 to 6 below and write it in the space next to each question.

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

_______ 1. Doing well in science is very important to me.

_______ 2. If a science assignment is hard, it means I'll probably learn a lot doing it.

_______ 3. In general, I find science to be very interesting.

_______ 4. I do my science homework all the time.

_______ 5. Your science intelligence is something about you that you can't change very much.

_______ 6. I like science very much.

_______ 7. What I learn in science applies to my life.

_______ 8. If you're not doing well at science, it's better to try something easier.

_______ 9. My future career will involve science.

_______ 10. I would like to take more science courses in the future.

_______ 11. I really pay attention in science class.

_______ 12. Success in science is very valuable to me.

_______ 13. I try to learn about science topics outside of school time.

_______ 14. If science is hard for someone, it means that he or she probably won't be able to do really well at it.

_______ 15. When I study for science, I put forth my best effort.

_______ 16. You have a certain amount of intelligence in science, and you really can't do much to change it.

Part 2 Directions

Please circle one of the numbers from 1 to 6 below.

17. How good at science are you?

1	2	3	4	5	6
Not at all Good					Very Good

18. If you were to list all of the students in your class from worst to best in science, where would you put yourself?

1	2	3	4	5	6
One of the Worst					One of the Best

19. How have you been doing in science this year?

1	2	3	4	5	6
Very Poorly					Very Well

Part 3 Directions

Please select one of the numbers from 1 to 6 below and write it in the space next to each question.

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

_______ 20. The harder you work at science, the better you will be at it.

_______ 21. I believe that science topics are important for my future.

_______ 22. You can learn new things, but you can't really change your basic intelligence in science.

_______ 23. You can always greatly change how intelligent you are in science.

_______ 24. Being good at science is an important part of who I am.

_______ 25. No matter how much intelligence you have in science, you can always change it a good amount.

_______ 26. To tell the truth, when I work hard at science, it makes me feel like I'm not very smart.

_______ 27. In the future, I will have a career that requires me to understand science.

_______ 28. It doesn't matter how hard you work – if you're not smart in science, you won't do well in it.

_______ 29. It matters to me how well I do in science.

_______ 30. If you're not good at science, working hard won't make you good at it.

_______ 31. No matter who you are, you can change your intelligence in science a lot.

_______ 32. When science is hard, it just makes me want to work more on it, not less.

_______ 33. In general, science is useful to me.

_______ 34. If you don't work hard at science and put in a lot of effort, you probably won't do well.

Part 4 Directions

Please answer each of the following questions by selecting one of the numbers from 1 to 5 below and writing it in the space next to each question.

1	2	3	4	5
not at all true		somewhat true		very true

_______ 35. It's important to me that I learn a lot of new science concepts this year.

_______ 36. One of my goals in science class is to learn as much as I can.

_______ 37. One of my goals is to master a lot of new science skills this year.

_______ 38. It's important to me that I thoroughly understand my science class work.

_______ 39. It's important to me that I improve my science skills this year.

Part 5 Directions

Please select one of the numbers from 1 to 5 below and write it in the space next to each question.

1	2	3	4	5
Never	Seldom	Sometimes	Often	Always

_______ 40. I know when I understand something in science.

_______ 41. I can make myself learn in science when I need to.

_______ 42. I try to use ways of studying that have worked for me before in science.

_______ 43. In science, I know what the teacher expects me to learn.

_______ 44. I learn best when I already know something about the topic in science.

_______ 45. I draw pictures or diagrams to help me understand while learning science.

_______ 46. In science when I am done with my work, I ask myself if I learned what I wanted to learn.

_______ 47. I think of several ways to solve a science problem and then choose the best one.

_______ 48. I think about what I need to learn in science before I start working.

_______ 49. In science, I ask myself how well I am doing while I am learning something new.

_______ 50. I really pay attention to important information in science.

_______ 51. In science, I learn more when I am interested in the topic.

_______ 52. I use my learning strengths to make up for my weaknesses in science.

_______ 53. In science, I use different learning strategies depending on the task.

_______ 54. I occasionally check to make sure I'll get my science work done on time.

_______ 55. I sometimes use learning strategies in science without thinking.

_______ 56. I ask myself if there was an easier way to do things after I finish a science task.

_______ 57. In science, I decide what I need to get done before I start a task.

Please go to the next page…

Part 6 Directions

When you read the following story, pretend that it really happened to you and try to picture how you would feel and what you would do if it happened.

You start a new science class at the beginning of the year and you really like science and the science teacher. You think you know science pretty well, so you study a medium amount for the first quiz. After the quiz, you think you did okay, even though there were some questions you didn't know the answer for. Then the class gets their quizzes back and you find out your score: you only got a 54, and that's an F.

What would you think was the main reason why you failed the quiz? The reason why I failed the quiz was that…

1	2	3	4	5	6
Not at all true					Very true

_______ 58. I wasn't smart enough.

_______ 59. the test was unfair, too hard for the class.

_______ 60. I'm just not good at science.

_______ 61. I didn't really like science that much.

What do you think that you would do next?

1	2	3	4	5	6
Not at all true					Very true

_______ 62. I would work harder in science class from now on.

_______ 63. I would spend more time studying for science tests.

_______ 64. I would try not to take science ever again.

_______ 65. I would spend less time on science from now on.

_______ 66. I would try to cheat on the next science test.

Part 7

67. Your Gender: *(circle one)* 1. Female 2. Male

68. Your Race: *(circle one)*

1. White or Caucasian (not Hispanic)
2. Black or African-American
3. Hispanic
4. Asian or Pacific Islander
5. American Indian
6. Other

69. Your Grade Level: *(circle one)* *6th grade* *7th grade*

You are finished! Thank you!

Appendix D

County B Teacher Script

Teachers - Thank you for your assistance in this research study! Your participation is greatly appreciated. Please read the following to your students before they begin answering the survey:

This survey is part of a research study being conducted by researchers at Virginia Tech. We are very interested to know what students at your school think about science, so we need your help. To find out what you think, we would like you to answer some questions about science and school. Many of the questions may sound similar, but it is very important that you answer every one. Please do not put any of your personal information, such as your name, on the survey. Participation is totally voluntary, and you are free to choose not to participate if you don’t want to. This research is important because it will help us help other students who are not doing well in school, so please answer as honestly as you can.

Appendix E

County B Parent Opt-Out Form
November 3, 2011

Dear Parents:

Educational researchers at Virginia Tech are partnering with Wythe County Public Schools to learn more about how sixth and seventh grade students feel about science and science classes. This information is important because it can help educators better understand how to motivate students in school.
We would like to ask all 6th and 7th grade students some questions about how they feel about science and school using a questionnaire, "*Survey on Academic Motivation in Science*". The questions take approximately 15-20 minutes to answer and students are instructed **NOT to put any personal or identifying information** on the survey such as their name, address, telephone, school, course grade, etc. Students' responses will be confidential and will only be shared with the researchers. Completion of the survey will not impact any students' grades. Below is an example of the questions on the survey:

Please select one of the numbers from 1 to 6 below and write it in the space next to each question.

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

______1. Doing well in science is very important to me.

______2. The harder you work at science, the better you will be at it.

If you do not wish for your student to participate in this survey, please fill out the opt-out form below and return it by **Thursday, November 17th**. Students who return this opt-out form will not be asked to fill out the survey.

Opt-Out Form:

Must Be Returned by : Thursday, November 17th

On ____Thursday, November 17th_____ the *Survey on Academic Motivation in Science* will be given to my child. I ***do not*** wish for my child to complete the survey.

______________________ ______________________ __________
Student's Name **Parent's Signature** **Date**

Appendix F

County A Institutional Review Board Approval Letter

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: December 2, 2011

TO: Brett Jones, Lauren Bryant, Jonathan Fink, Michael Evans

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: Giles County Students' Science Beliefs Starting Fall 2011

IRB NUMBER: 11-959

Effective December 2, 2011, the Virginia Tech IRB Administrator, Carmen T. Green, approved the new protocol for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Exempt, under 45 CFR 46.101(b) category(ies) 1**
Protocol Approval Date: **12/2/2011**
Protocol Expiration Date: **NA**
Continuing Review Due Date*: **NA**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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Appendix G

County B Institutional Review Board Approval Letter

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: November 28, 2011

TO: Brett Jones, Lauren Bryant

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: Self-Theories of Intelligence and Metacognition in Rural Middle School Students

IRB NUMBER: 11-956

Effective November 22, 2011, the Virginia Tech IRB Administrator, Carmen T. Green, approved the new protocol for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Exempt, under 45 CFR 46.101(b) category(ies) 1**
Protocol Approval Date: **11/22/2011**
Protocol Expiration Date: **NA**
Continuing Review Due Date*: **NA**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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