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Relationship Between Noncognitive Skills and Mathematics Achievement

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This is to certify that the doctoral study by

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Abstract

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MA, Stockton University, 2011

BA, Stockton University, 2006

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Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Despite ongoing efforts to improve curriculum and instruction, students at an urban high school in New Jersey score low on the mathematics achievement components of the Partnership for Assessment of Readiness for College and Careers (PARCC) exam. Guided by Bandura's social cognitive theory, the purpose of this quantitative study was to investigate the relationship between students' noncognitive skills and their mathematics achievement. Students who were enrolled in the local high school in the 2017-18 school year and had completed the geometry component of the PARCC exam in 2016-17 were invited to participate in this study. In this cross-sectional survey design, 97 students completed 3 self-report noncognitive skills surveys measuring their mindset, grit, and self-control. Each noncognitive skill score was correlated with the students' mathematics achievement as measured by their 2016-17 geometry PARCC exam score. Pearson correlation analysis indicated no significant correlations between each of the 3 noncognitive skills and mathematics achievement. While some prior research suggested that developing noncognitive skills can be a basis for effective interventions, these results do not support that approach. Given that there was no significant relationship between noncognitive skills and mathematics achievement in this sample, a prudent next step seemed to be recommending an individualized instructional approach to working with students as a means for addressing mathematics skills. Thus, a policy recommendation was developed to promote a comprehensive and evaluative approach to instructional decision-making that can be individualized for each student. By adopting instructional practices that individualize decision-making for each student's needs, positive social change is likely to occur as students' mathematics achievement may increase over time.

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Section 1: The Problem

Introduction

Most of the United States has adopted the Common Core State Standards (CCSS), or similar state standards, in an attempt to provide a high-quality education for all students. These rigorous standards may be challenging for some school districts more than others, especially the ones that had difficulty meeting achievement goals before the new standards. The adoption of the CCSS alone will not increase mathematics achievement, but attention to the individual needs of the students to help them become better mathematical thinkers may help guide school districts to higher achievement (Schoenfeld, 2014). Educators implement many of the external factors related to student learning, but they may be overlooking some very important internal factors called noncognitive skills.

Some researchers focused on the relationship between achievement and socioeconomic status, with economically disadvantaged students showing lower academic success (Reardon, 2013). From a different perspective, other researchers examined the value of learning the noncognitive skills academic mindset and academic perseverance (Duckworth & Yeager, 2015; Dweck, Walton, & Cohen, 2011; Farrington et al., 2012; Paunesku et al., 2015; Shechtman, DeBarger, Dornsife, Rosier, & Yarnall, 2013). Academic mindset is the mental approach or attitude a student has towards learning. Academic perseverance is the ability to get through difficult tasks in school. In this study I analyzed three noncognitive skills. The first skill was an academic mindset and the other two skills related to academic perseverance, specifically grit and self-control.

The Local Problem

Despite ongoing efforts to improve curriculum and instruction, low mathematics achievement scores on the Partnership for Assessment of Readiness for College and Careers (PARCC) exam existed at an urban high school in New Jersey. Only 16.4% of the students were meeting standards, which was very low compared to the state average of 43.5% (School Performance Report 2016-17, n.d.). According to Reardon (2013), there is a long history of low-income students performing worse than their peers on various forms of educational measurements. At this target urban high school in New Jersey, 79% of the students were considered economically disadvantaged (School Performance Report 2016-17, n.d.). Economically disadvantaged students score lower on average, but there are some students that perform well on state assessments regardless of socioeconomic status. One possible explanation of overcoming these obstacles is noncognitive skills.

To help address the low mathematics achievement a better understanding of the noncognitive skills academic mindset and academic perseverance is needed. Noncognitive skills have been called “soft skills” by some researchers because they are related to human constructs that are difficult to quantify in any way except self-reported survey responses (Heckman & Kautz, 2012). Education has a history of solely evaluating students and teachers by achievement scores, which may be a limited view (Shechtman et al., 2013). In this study I examined the prevalence of the noncognitive skills mindset, grit, and self-control to determine whether there was a relationship with mathematics achievement.

Rationale

Evidence of the Problem at the Local Level

According to recent data at an urban high school in New Jersey, there has been some school-wide improvement in overall mathematics achievement. The mathematics proficiency level on the New Jersey High School Proficiency Assessment (NJHSPA) was at 59% for the 2011-12 school year (School Performance Report 2011-12, n.d.). The percent proficient increased to 67% for the 2012-13 school year and increased again to 73% for the 2013-14 school year (School Performance Report 2012-13, n.d.; School Performance Report 2013-14, n.d.). These improving scores were encouraging to the mathematics department at the high school because many improvement efforts were implemented during those years.

Table 1

Mathematics Section of the NJHSPA at an Urban High School in New Jersey

	11-12	12-13	13-14
Percent Proficient on NJHSPA	59%	67%	73%

During the 2014-15 school year, the state assessment switched from the NJHSPA to the PARCC exam. These data were analyzed separately because it was a different exam based on the more rigorous CCSS. As shown in Table 2 below, the first three years of PARCC data indicated that school-wide mathematics achievement was very low and not increasing as rapidly as it did the previous three years on the NJHSPA (School Performance Report 2014-15, n.d.; School Performance Report 2015-16, n.d.; School Performance Report 2016-17, n.d.). The NJHSPA was a single exam that students took during their junior year, but the new PARCC exam evaluated each student on a yearly basis for the courses algebra 1, geometry, and algebra 2.

Table 2

Mathematics Section of the PARCC at an Urban High School in New Jersey

	14-15	15-16	16-17
Percent Met/Exceeded Expectations on PARCC	14%	15%	16%

Local data had focused predominantly on mathematics achievement without much attention to noncognitive skills. Some researchers have recognized that academic behaviors, such as grades and credits, can be indicators of noncognitive skills (Duckworth, Quinn, & Tsukayama, 2012; Farrington et al., 2012; Kautz & Zanoni, 2014). Low noncognitive skills can lead to poor academic behaviors, which can lead to bad grades and a lack of credits. Failing courses and not obtaining enough credits each year eventually leads to lower graduation rates. The graduation rate at the urban high school in New Jersey had improved over the last six years, but the most recent available data showed it was still well below the state average of 90.5% (School Performance Report 2011-12, n.d.; School Performance Report 2012-13, n.d.; School Performance Report 2013-14, n.d.; School Performance Report 2014-15, n.d.; School Performance Report 2015-16, n.d.; School Performance Report 2016-17, n.d.).

Table 3

Graduation Rate at an Urban High School in New Jersey

	11-12	12-13	13-14	14-15	15-16	16-17
Graduation Rate	70%	67%	70%	74%	76%	81%

Suspension rates can also be related to noncognitive skills, especially the academic perseverance skill self-control (Zimmerman & Kitsantas, 2014). Over the past six school years, the percent of students that had been suspended at least one time varied, and the most recent available data showed it was at 39% (School Performance Report 2011-12, n.d.; School Performance Report 2012-13, n.d.; School Performance Report 2013-14, n.d.; School Performance Report 2014-15, n.d.; School Performance Report 2015-16, n.d.; School Performance Report 2016-17, n.d.). Together, the low graduation rate and the high suspension rate indicated a problem with noncognitive skills at the local setting.

Table 4

Suspension Rate at an Urban High School in New Jersey

	11-12	12-13	13-14	14-15	15-16	16-17
Suspension Rate	26%	39%	41%	40%	23%	39%

Evidence of the Problem from the Professional Literature

Low mathematics achievement has been and still is a problem for many school districts in our country according to the National Assessment of Educational Progress

(NAEP) (Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Hemphill & Vanneman, 2011; Vanneman, Hamilton, Anderson, & Rahman, 2009). Murayama, Pekrun, Lichtenfeld, and vom Hofe (2013) discovered that intelligence quotient (IQ) was a strong predictor of initial mathematics achievement, but motivation and learning strategies were better predictors of more complex mathematics achievement. In this study I explored the value of the noncognitive skills academic mindset and academic perseverance, and shed light on a more comprehensive understanding of mathematics achievement.

Farrington et al. (2012) argued there was a logical sequence starting with academic mindsets, then to academic perseverance, then to academic behaviors, and finally to academic achievement. Trying to change behaviors without providing students with the internal motivation or perseverance skills required to do so is a limited approach. Similar to Farrington et al. (2012), Garcia (2014) argued that noncognitive skills help support cognitive development and claimed that noncognitive skills have been overlooked in education. Results from another study showed students with low cognitive abilities also had low noncognitive skills (Garcia, 2015). The research on this topic was limited, but it seemed plausible that a lack of noncognitive skills could be contributing to lower mathematics achievement that was later observed between economically disadvantaged students and their peers.

According to a national longitudinal study by Graham and Provost (2012), urban students started kindergarten with marginally lower mathematics achievement scores than suburban students and the gap increased over time. Even though many of the urban students scored lower on mathematics achievement than their suburban peers, some of them were able to overcome the socioeconomic barriers, possibly through the use of noncognitive skills. A focus on noncognitive skills instead of income or ethnicity can be much more productive because they are malleable constructs within the school's control (Garcia, McCluskey, & Taylor, 2015).

Shechtman et al. (2013) summarized the sociocultural factors that contribute to achievement gaps and their link to noncognitive skills that might benefit education and society as a whole. Dweck et al. (2011) also argued that students need noncognitive skills, especially during difficult transitions at school when new challenges usually arise. Transitions that students experience in school can continue throughout their entire life. People can endure these challenges if they have obtained the required noncognitive skills (Dweck et al., 2011). A review of the literature on noncognitive skills guided this project study to focus on academic mindset and academic perseverance. The purpose of this project study was to examine the relationship between noncognitive skills and mathematics achievement.

Definition of Terms

Noncognitive skills: A set of skills that includes academic mindsets, academic perseverance, and academic behaviors. Attributes that are not related to cognition. (Duckworth & Yeager, 2015; Farrington et al., 2012).

Academic behaviors: A set of indicators for noncognitive skills that include grades and credits (Duckworth, Weir et al., 2012; Farrington et al., 2012; Kautz & Zanoni, 2014).

Academic mindsets: To succeed in school students must be in the right frame of mind to support learning opportunities and stay motivated (Paunesku et al., 2015; Shechtman et al., 2013).

Academic perseverance: A group of noncognitive skills that promote determination. This group includes grit and self-control as two different types of perseverance (Duckworth & Yeager, 2015; Farrington et al., 2012).

Grit: A noncognitive skill that drives students to work harder and stay focused on their goals. Grit is a type of perseverance that relates more to long-term success and goals (Duckworth, Peterson, Matthews, & Kelly, 2007; Duckworth & Yeager, 2015).

Self-Control: A noncognitive skill similar to grit because it is a form of perseverance, but more related to short-term goals and regulation of impulses (Duckworth, Gendler, & Gross, 2014).

Self-Efficacy: The internal belief that goals can be accomplished (Bandura, 1990; Dweck, 2006).

Significance of the Study

Mathematics is a significant topic for our country according to federal policy that has been implemented in response to our current world economic standing. Kuenzi (2008) explained that the United States ranks low compared to other nations in the Science, Technology, Engineering, and Mathematics (STEM) fields. Our schools were failing to adequately prepare students because many of them were scoring poorly on international exams in Mathematics and Science (Kuenzi, 2008). A more recent source shows that we were still lagging behind many nations on the Program for International

Student Assessment (PISA). According to the PEW Research Center, in 2015 the United States ranked 38th in mathematics on the PISA (Desilver, 2017). Like many other school districts in our country, this urban high school in New Jersey was struggling to meet standards in mathematics.

This study addressed the problem of low mathematics achievement and insufficient understanding about noncognitive skills. Improvements to school-level factors at the local site seemed to help overall achievement for three years on the NJHSPA, but the improvement leveled off with the new PARCC exams. To get more students to succeed on these more challenging exams, schools should provide a more supportive learning environment that addresses various needs (Brown, Benkovitz, Muttillo, & Urban, 2011). Many school districts, especially this urban high school in New Jersey, are still struggling to find practical solutions to low mathematics achievement scores (Bohrnstedt et al., 2015; Hemphill & Vanneman, 2011; High School Proficiency Assessment, n.d.; NJ State Board of Education, 2015; School Performance Report 2013-14, n.d.; Vanneman et al., 2009).

A better understanding of noncognitive skills may lead to a transition away from traditional instructional practices to a more comprehensive approach that values academic mindset and academic perseverance. Goldammer (2012) showed that better economic outcomes were more likely related to differences in noncognitive skills than cognitive abilities. The research on noncognitive skills is still developing, but it is showing very interesting results. In a review of high school improvement strategies, researchers claimed that recent literature has shown noncognitive skill interventions may be more cost-effective than other strategies (Cullen, Levitt, Robertson, & Sadoff, 2013).

In a report titled *Promoting Grit, Tenacity, and Perseverance: Critical Factors for Success in the 21st Century*, the authors called for education reform that included the use of noncognitive skills (Shechtman et al., 2013). The report also suggested that education should no longer teach to the test, but instead, shift towards developing well-rounded members of society that can confront and succeed when faced with difficult challenges (Shechtman et al., 2013). Other researchers have also suggested that noncognitive skills were a significant topic worthy of research because too many schools are focused solely on cognitive abilities measured by standardized test data (Dweck et al., 2011; Farrington et al., 2012).

Research Questions

Despite ongoing efforts to improve curriculum and instruction, low mathematics achievement scores on the PARCC exam existed at an urban high school in New Jersey. The purpose of this study was to investigate the relationship between noncognitive skills and mathematics achievement. The Implicit Theories of Intelligence Scale was used to quantify academic mindset. Also, the Grit Scale and Self-control Scale were used to measure two different types of academic perseverance. This study was guided by the following research questions:

1. What is the relationship between academic mindset as measured by the Implicit Theories of Intelligence Scale and mathematics achievement as measured by the most recent geometry PARCC data?

H_0: There is no relationship between academic mindset as measured by the Implicit Theories of Intelligence Scale and mathematics achievement as measured by the most recent geometry PARCC data.

H_a: There is a relationship between academic mindset as measured by the Implicit Theories of Intelligence Scale and mathematics achievement as measured by the most recent geometry PARCC data.

2. What is the relationship between academic perseverance as measured by the Grit Scale and mathematics achievement as measured by the most recent geometry PARCC data?

   H_0: There is no relationship between academic perseverance as measured by the Grit Scale and mathematics achievement as measured by the most recent geometry PARCC data.

   H_a: There is a relationship between academic perseverance as measured by the Grit Scale and mathematics achievement as measured by the most recent geometry PARCC data.

3. What is the relationship between academic perseverance as measured by the Self-Control Scale and mathematics achievement as measured by the most recent geometry PARCC data?

   H_0: There is no relationship between academic perseverance as measured by the Self-Control Scale and mathematics achievement as measured by the most recent geometry PARCC data.

H_a: There is a relationship between academic perseverance as measured by the Self-Control Scale and mathematics achievement as measured by the most recent geometry PARCC data.

4. To what extent can academic mindset as measured by the Implicit Theories of Intelligence Scale predict mathematics achievement as measured by the most recent geometry PARCC data?

   H_0: There is no significant linear relationship between academic mindset as measured by the Implicit Theories of Intelligence Scale and mathematics achievement as measured by the most recent geometry PARCC data.

   H_a: There is a significant linear relationship between academic mindset as measured by the Implicit Theories of Intelligence Scale and mathematics achievement as measured by the most recent geometry PARCC data.

5. To what extent can academic perseverance as measured by the Grit Scale predict mathematics achievement as measured by the most recent geometry PARCC data?

   H_0: There is no significant linear relationship between academic perseverance as measured by the Grit Scale and mathematics achievement as measured by the most recent geometry PARCC data.

   H_a: There is a significant linear relationship between academic perseverance as measured by the Grit Scale and mathematics achievement as measured by the most recent geometry PARCC data.

6. To what extent can academic perseverance as measured by the Self-Control Scale predict mathematics achievement as measured by the most recent geometry PARCC data?

   H_0: There is no significant linear relationship between academic perseverance as measured by the Self-Control Scale and mathematics achievement as measured by the most recent geometry PARCC data.

   H_a: There is a significant linear relationship between academic perseverance as measured by the Self-Control Scale and mathematics achievement as measured by the most recent geometry PARCC data.

Review of the Literature

Introduction

The review of the literature was compiled using Google scholar and various Walden library educational databases. The databases included ERIC, Educational Research Complete, and SAGE Premier. The main search terms included: *noncognitive skills, mindset, grit, self-control, mathematics, achievement, motivation, perseverance, resilience,* and *self-efficacy*. Other research articles were located by searching for authors after some experts on the topics were recognized. This section synthesized the literature related to this study by using the following headings: Theoretical Framework, Mathematics Achievement, Achievement and Noncognitive Skills, Mindset, Grit, and Self-Control.

Theoretical Framework

The theoretical framework for this study was Albert Bandura's social cognitive theory, which is an extension of his earlier work social learning theory. Social cognitive theory differs from previous learning theories because it suggested that humans have personal agency and can influence their environment just as their environment influences them (Bandura, 1986). In the book *Social Foundations of Thought and Action: A Social Cognitive Theory*, Bandura described that humans are not simply products of their surroundings, but they are complex beings that are constantly influenced by internal and external factors (Bandura, 1986). These ongoing and concurrent factors are what shape our beliefs and behaviors. Social cognitive theory as a theoretical framework was a good fit for this study because external improvements in education cannot solely change behavior; internal changes to academic mindset and academic perseverance also need to happen for students to alter their future behaviors and increase mathematics achievement.

Bandura continued to write about social cognitive theory and its potential applications. He believed that a better understanding of how individual factors are formed could help organizations model the types of behaviors they desire and motivate individuals to succeed (Bandura, 1988). The world of education has based its structure around the concept that we can model desired behavior for students to imitate, but sometimes the individual does not want to, or chooses not to, imitate those desired behaviors for various reasons. Human behaviors are influenced by constant self-regulation and self-evaluation of the consequences to one's actions (Bandura, 1991). Education as a whole has devalued noncognitive skills by putting too much emphasis on standardized testing (Shechtman et al., 2013). An organizational structure, such as a school, could increase the value of the academic mindset and academic perseverance to assist students internally to alter their future academic behaviors.

Self-efficacy has been recognized as an important quality within social cognitive theory because monitoring thoughts and regulating behaviors are critical to success in education (Bandura, 1990). Collins (1982) showed that students of various ability levels with high self-efficacy outperformed students of similar abilities on a mathematics exam. Self-efficacy has also been widely recognized as a skill that can help students stay motivated and accomplish their goals (Bandura, 1993). On the surface, it seems logical that more confidence leads to higher levels of success. Unfortunately, a sole focus on confidence without the support of internal factors can develop students that only seek simple accomplishments and avoid challenges (Dweck, 2006). Academic mindset and academic perseverance are two internal skills that can help support students during more difficult challenges.

In *Motivational Processes Affecting Learning*, Dweck (1986) applied social cognitive theory as a framework to explain how students reacted to outcomes and how those outcomes affected future motivation. This research on motivation and intelligence developed into the book titled *Self-Theories* in which two distinct theories of intelligence were defined. Students tended to have either a theory of fixed intelligence in which they preferred easy tasks, feeling smart, and avoiding challenges. The other theory was malleable intelligence in which students realized that challenging tasks and failure are part the learning process (Dweck, 2000). This research revealed that talents were not the limits of success, it also incorporated the belief that the amount of intellignece someone has can be increased with effort. Dweck (2006) later coined the phrases “fixed mindset” and “growth mindset” to describe these two theories of intelligence in the popular book titled *Mindset: The New Psychology of Success*.

Mathematics Achievement

Low mathematics achievement observed in high school begins early in life. In a research study, preschool mathematics abilities measured at 54 months old predicted mathematics achievement to age 15 years; the researchers also discovered that the gains made from preschool to first grade were even stronger predictors of high school mathematics achievement (Watts, Duncan, Siegler, & Davis-Kean, 2014). In a similar study related to the early stages of life, researchers found that children who started kindergarten proficient in mathematics outperformed their peers by the end of the school year regardless of their ethnicity (Sonnenschein & Galindo, 2014). In both studies, researchers showed that schools can start addressing low mathematics achievement during the earliest stages of education.

There are many indicators for educators to recognize low mathematics achievement in the future. Fractional knowledge has been long recognized as a skill that is one of the strongest predictors of future mathematics achievement (Ye et al., 2016). While mathematics skills are important to have as part of a strong foundation, a study of fourth graders in China showed that working memory and motivation were also both strong predictors of future mathematics achievement (Lu, Weber, Spinath, & Shi, 2011). These researchers showed that skill building, cognitive traits, and noncognitive skills were all important to develop in education. By recognizing indicators of future mathematics success early in life, school districts can be better prepared with interventions for students and prevent mathematics achievement gaps from widening.

Improving mathematics achievement is a challenge for many school districts. Singh (2015) highlighted the importance of trying to increase achievement with an increased focus on the needs of each individual student. Singh found that individual traits were four times better than school-level traits at predicting later mathematics achievement (Singh, 2015). One way to focus on an individual's needs is through professional learning communities (PLCs) because they allow teachers to work together and find creative solutions to difficult problems (Garcia et al., 2015; Killion & Roy, 2009). PLCs can help mathematics teachers transition from traditional teaching methods to more innovative practices (Chauraya & Brodie, 2017). Together, this research supports the notion that much more effort has to be put into supporting the individual factors that influence mathematics achievement.

Mathematics courses can be intimidating for some students, especially the ones that recognize they were falling behind their peers. An international study found that 15-year-olds with access to homework resources and with higher levels of self-efficacy had higher mathematics achievement (Kitsantas, Cheema, & Ware, 2011). Similarly, Stankov, Morony, and Lee (2014) concluded that of all the noncognitive skills, confidence was the best predictor of academic achievement. Both of these researchers showed that skill building along with confidence was an important combination for increasing mathematics achievement. Providing additional resources to build confidence is a valid strategy, but building self-esteem by incorrectly encouraging students for simple tasks can be counterproductive (Dweck, 2006). It should be the responsibility of a school to monitor and properly support both cognitive and noncognitive skills of all students.

Low mathematics achievement has been well documented in our country by the NAEP (Bohrnstedt et al., 2015; Hemphill & Vanneman, 2011; Vanneman et al., 2009). Many practitioners have tried to increase achievement through various methods. One potential solution is school choice, which allows students of certain neighborhoods to attend a different school than the district they live in. Allowing this choice is supposed to help students go to better schools and create more diversity in schools that were recognized as higher achieving (Fruchter, Hester, Mokhtar, & Shahn, 2012). The Annenberg Institute for School Reform at Brown University studied the effects of school choice implemented in New York City. School choice can put students in schools with higher achievement data, but it does not guarantee those schools will address individual student needs that are required to increase achievement for all students (Moller, Mickelson, Stearns, Banerjee, & Bottia, 2013; Singh, 2015).

To increase mathematics achievement there is a need for consistent highly-qualified teachers working together in schools (Garcia et al., 2015; Killion & Roy, 2009). Simon and Johnson (2015) showed that high-poverty schools tended to have high teacher turnover due to poor working conditions, not student characteristics. With high teacher turnover, it can be difficult to build a staff of quality teachers that can foster a supportive school culture for all students to succeed (Moller et al., 2013). According to Brown et al. (2011), schools with higher academic achievement often supported students, gave teachers feedback, and had higher expectations. There is a need for better schools, but many of the current solutions do not specifically address the internal needs or the noncognitive skills of the students.

Achievement and Noncognitive Skills

Before students reach school age, they have some very important developmental years at home that set the tone for their future academic achievement. Wanless, McClelland, Tominey, and Acock (2011) studied demographic risk factors of prekindergarten and kindergarten children, these risk factors seem to be affecting low-income neighborhoods the most. Their findings suggested that behavior regulation of students from low-income households was much lower than their peers and English language learners had a slower behavior regulation growth rate (Wanless et al., 2011). Low levels of parental involvement in the education process could be contributing to lower academic achievement. LaRocque, Kleiman, and Darling (2011) argued that parental involvement should receive some of the blame for low scores on standardized testing, but the researchers also encouraged schools to start better training their teachers. These research studies highlighted that parental involvement was crucial to a child's success in school and life.

Noncognitive skills have been linked to many successful outcomes later in life. Almlund, Duckworth, Heckman, and Kautz (2011) showed that personality traits have a causal relationship with academic and economic success. In a similar study of 12 and 13-year-old boys, researchers found compliance and compassion to be very important attributes for predicting life success and better personal relationships 10 years later (Kern et al., 2013). Likewise, another study of Americans over 50 years old found that conscientious adults reported higher income and happier lives (Duckworth, Weir, Tsukayama, & Kwok, 2012). These studies all contained longitudinal data that showed noncognitive skills were related to successful outcomes later in life.

The research showed that low achievement was well explained by the socio-economic status of the students (Reardon, 2013). Unfortunately, there is very little a school district can do to change the incomes of the families they serve. Garcia (2015) recognizes the strong connection between socioeconomic status and achievement, but more importantly connected noncognitive skills with achievement. This connection is significant because noncognitive skills are much more malleable than socioeconomic status. In a study done in Australia, the researcher concluded that the noncognitive skill persistence was more related to student achievement than family income (Marks, 2016). It is imperative to analyze all the sociocultural factors when analyzing achievement, including noncognitive skills (Duckworth & Yeager, 2015; Shechtman et al., 2013).

Noncognitive skills may help explain why some students were able to overcome the inherent barriers. One study showed that increased noncognitive skills helped reduce the negative effects of socioeconomic status on achievement (Liu, 2016). This would clarify why socioeconomic factors are strong predictors of achievement, but some students are able to overcome the barriers of low socioeconomic status. Another study by Xie and Hsin (2014), found that Asian Americans were excelling because of effort and not an advantage in cognitive abilities. They also concluded that it was a cultural difference that increased their effort (Xie & Hsin, 2014). Noncognitive skills are most likely developed and supported by the parents of high achieving students. Schools may be lacking attention towards noncognitive skills because they are mostly focused on standardized test data. Fortunately, some of the research is now supporting the idea of using noncognitive skills to address low achievement (Dweck et al., 2011; Farrington et al., 2012; Kautz & Zanoni, 2014; Shechtman et al., 2013).

Mindset

Dweck (2006) wrote the book *Mindset: The New Psychology of Success*, which describes two types of people and the differences in the way they think about intelligence. These mindsets were related to her work on implicit theories of intelligence and can be applied to sports, business, relationships, and education (Dweck, 2006). People either fall into a fixed mindset or a growth mindset mentality which can greatly benefit or hinder how people learn (Dweck, 2010). Parents and educators play a large role in teaching children to think about academic success because our comments and types of praise can be very influential to the minds of children (Dweck, 2006). Mindset is a noncognitive skill which can be highly influenced by parents and teachers, so it should be included in the curriculum when trying to increase achievement (Dweck, 2010).

Student engagement is an important characteristic of increased achievement for low-performing students (Finn & Zimmer, 2012). Engagement levels can be low when educators teach to the test because basic recall skills are generally more emphasized than critical thinking skills (Shechtman et al., 2013). Carpenter and Pease (2013) argued that students need to be active participants in learning, and concluded that developing an academic mindset will help students claim responsibility for their own education. Farrington et al. (2012) supported the implementation of the CCSS, but similarly argued that the high level of expectations will not be possible without the development of noncognitive skills in education. In a framework developed by Farrington et al. (2012), academic mindset was given top priority of all the noncognitive skills because students need a theory of malleable intelligence before they can improve academic perseverance and academic behaviors, which can eventually lead to increased academic achievement.

There are many transitions in education such as elementary school to middle school, middle school to high school, and high school to college or the workforce. These transitions can be tough without the will to accept new challenges. In a report about academic tenacity, Dweck et al. (2011) described students with fixed mindsets that tended to give up when faced with new challenges. Students with growth mindsets tended to rise to the occasion without being discouraged by setbacks (Dweck et al., 2011). In another report on academic mindsets by Snipes, Fancsali, and Stoker (2012), the authors reviewed the current interventions and discovered that there were many promising studies that indicated it was possible to teach students a growth mindset. Their review of the research called for replicating the results of the studies and focusing on at-risk students (Snipes et al., 2012). The results of these studies supported the idea that a growth mindset can help students become more willing to accept challenges.

An online intervention program called Brainology allows students to work on interactive lessons that were focused on encouraging a growth mindset (Mindset Works, n.d.). Donohoe, Topping, and Hannah (2012) used a mixed method study to analyze the effectiveness of Brainology, their results indicated an increased mindset score for participants, but they were not sustained over time. Future research called for a prolonged solution to strengthening academic mindsets for students (Donohoe et al., 2012). In a similar study, researchers concluded that the use of engaging video games could be used to increase mindset scores and persistence (O'Rourke, Haimovitz, Ballwebber, Dweck, & Popović, 2014). Both of these studies focused on interventions that would increase a student's growth mindset score, but not necessarily sustain it. Similarly, Paunesku et al. (2015) showed that online mindset lessons helped increase academic achievement for at-risk high school students.

Grit

Some people appear to be more passionate than others about pursuing their goals and reaching high levels of achievement, but it might not happen naturally, it might be a malleable skill that can be taught to students (Farrington et al., 2012). Duckworth, Kirby, Tsukayama, Berstein, and Ericsson (2011) studied National Spelling Bee participants and discovered that higher grit scores accompanied better spellers. The researchers concluded that having grit helped the participants better prepare for the competition even though their preparation style was less enjoyable (Duckworth et al., 2011). A similar study found that grit was a common quality of people who stayed in the military, held jobs for longer periods of time, graduated from high school, and had longer marriages (Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014). These studies supported the idea that grit was a trait that helps people persist when challenges or setbacks arise. The ability to persevere could highly benefit struggling students and help increase mathematics achievement in high school.

Silvia, Eddington, Beaty, Nusbaum, and Kwapil (2013) studied how grit scores were related to effort exerted on a cardiac level, results supported their hypothesis that grittier individuals tried harder. The results of the study showed there was a physical difference, the greater the effort exerted, the greater the change in heart rate (Silvia et al., 2013). So where does grit fit into the world of education? In his book *Fostering Grit: How do I prepare my students for the real world*, Hoerr (2013) outlined why grit is important and provided a six-step approach for teaching grit in the classroom. The author encouraged educators to talk to students about grit and to also make it part of the school culture (Hoerr, 2013). Making grit a theme throughout the school might help students develop sustained academic perseverance, which could lead to increasing mathematics achievement.

Grit is a noncognitive skill that can help students, but it is also a skill that can be beneficial for teachers. Gloria, Faulk, and Steinhardt (2013) explained that not all teachers get burnout, some were able to handle the high demands of the profession. A study of public school teachers showed that burnout was correlated with work stress and inversely correlated with perseverance (Gloria et al., 2013). Teacher burnout levels have also been linked with student stress regulation (Oberle & Schonert-Reichl, 2016). Another study about novice teachers showed that grittier teachers were more likely to stay in the profession and received higher effectiveness ratings (Robertson-Kraft & Duckworth, 2014). These studies reinforced the importance of perseverance in teachers, especially during their challenging novice years. Qualities that teachers have and value are more likely to be transferred to their students (Bandura, 1988).

Duckworth et al. (2007) defined grit as the determination to complete difficult tasks and maintain progress towards goals over a long period of time. Von Culin, Tsukayama, and Duckworth (2014) explained that there are different types of happiness that people pursue: engagement, meaning, and pleasure. They discovered that individuals with higher grit scores were more likely to seek activities that engaged them and had significance while other people who were less gritty tended to seek activities that provided them with pleasure (Von Culin et al., 2014). For some high school children, impulse control can be difficult and the promise of a better life due to education does not entice them enough to change their behaviors. Duckworth and Gross (2014) described grit and self-control as similar, but different traits of successful people. Both traits help individuals persevere, but grit was related to long-term happiness while self-control was more related to momentary pleasure (Duckworth & Gross, 2014).

Self-Control

In the famous marshmallow experiment at Stanford University, children were put in front of a marshmallow and told if they can wait to eat it they would be rewarded with an additional treat (Mischel, Ebbesen, & Raskoff Zeiss, 1972). The children that were able to wait, or demonstrated delayed gratification, had better educational outcomes later in life (Mischel et al., 1972). Duckworth, Tsukayama, and Kirby (2013) linked delay-of-gratification to self-control ratings and showed that children who waited longer to eat the marshmallow also tended to score higher on a self-control scale. Also, the students who waited longer did not demonstrate higher IQ scores (Duckworth, Tsukayama et al., 2013). In a similar study, self-control was linked to the ability to resist drugs and alcohol during high school and college years, also the findings showed that participants did not demonstrate more self-control as they aged (Romer, Duckworth, Sznitman, & Park, 2010). These research studies showed that self-control was a measurable noncognitive skill that does not necessarily develop naturally with age. This project study aimed to learn more about how self-control was related to education and mathematics achievement.

Self-control has been a well-established predictor of various life outcomes. A 32-year longitudinal study showed that it has a strong predictive relationship of better future physical health, lower substance dependence, better personal finances, and lower criminal offending outcomes (Moffitt et al., 2011). A similar study by Duckworth, Tsukayama, and May (2010) showed causation between self-control and GPA, suggesting that other possible variables such as IQ, gender, ethnicity, or income were not confounding the results. The researchers also concluded that self-esteem did not confound the results, and they believed that self-control actually accounted for the relationship between self-esteem and academic achievement (Duckworth et al., 2010). It is possible that some children are entering school with self-esteem and plenty of confidence, but are falling behind in mathematics because they have been praised for simple accomplishments instead of challenging themselves (Dweck, 2006).

Self-control limits the number of distractions and interruptions to the daily learning environment and allows a student to stay focused on the lessons being taught. A study by Duckworth, Kim, and Tsukayama (2013) suggested that stressful outcomes in life reduced a student's ability to demonstrate self-control in class. When there are high levels of stress outside of school, students may devalue education and put forth less effort, causing them to fall further behind their peers every school year (Duckworth, Kim et al., 2013). For this reason, Duckworth et al. (2014) outlined various strategies for implementing self-control interventions for students. The authors concluded that the earlier interventions are put in place, the more successfully they can positively affect behavior (Duckworth et al., 2014). Educators should work on developing self-control skills for their students even if they lead stressful lives outside of school, which may be the case for many economically disadvantaged students (Wanless et al., 2011).

Educators and researchers have been searching for solutions to increase mathematics achievement for a long time, but overall, low performance still existed (Bohrnstedt et al., 2015; Hemphill & Vanneman, 2011; Vanneman et al., 2009). A strong predictor of standardized test results is still a student's IQ score, but a better predictor of grades and a more malleable skill is self-control (Duckworth, Quinn et al., 2012). The noncognitive skill self-control can help students improve academic perseverance in the classroom, but its impact may not be quickly reflected on standardized test measures, which may give them a lower priority in the classroom than cognitive skills (Farrington et al., 2012).

Yeager et al. (2014) argued that students would benefit from learning how to regulate their own learning. The noncognitive skills mindset, grit, and self-control might help students become motivated, confident, persistent, and self-regulated learners

(Yeager et al., 2014). Zimmerman and Kitsantas (2014) showed that self-regulation was a predictor of academic achievement. If these noncognitive skills are ingrained and sustained in an organization, they are more likely to be valued by all the members of the organization (Bandura, 1988). A more well-rounded approach that includes developing cognitive and noncognitive skills may help increase mathematics achievement.

Implications

This project study analyzed mindset scores, grit scores, self-control scores, and geometry PARCC scores. The analysis included examining the relationship between noncognitive skills derived from relevant survey questions and preexisting mathematics achievement data. The results from this study were used to develop a project deliverable. The project was a policy recommendation to inform the school and district leadership teams on noncognitive skills and their relationship to mathematics achievement. The policymakers can use this information to help determine future curriculum, instruction, and assessment decisions. More informed decisions can increase student learning and help create positive social change. Stakeholders also included students, teachers, parents, and community members. A summary of the research was submitted to the school newsletter when the project was completed so that all stakeholders had a chance to see the results. Additionally, an executive summary was sent to all participants to assure they had a chance to see the results of the study.

Summary

At an urban high school in New Jersey, overall mathematics achievement showed some improvement, but compared to other schools in the state, was still relatively low

(School Performance Report 2011-12, n.d.; School Performance Report 2012-13, n.d.; School Performance Report 2013-14, n.d.; School Performance Report 2014-15, n.d.; School Performance Report 2015-16, n.d.; School Performance Report 2016-17, n.d.). This was a local problem that was also a national problem, as low mathematics achievement also existed on the 8^{th}-grade mathematics NAEP (Bohrnstedt et al., 2015; Hemphill & Vanneman, 2011; Vanneman et al., 2009). Low mathematics achievement is difficult to address in high school because the students with lower cognitive abilities tend to start behind and fall further behind each school year (Graham & Provost, 2012).

Some of the current literature is calling for a shift in education that includes the use of noncognitive skills to assist struggling students (Dweck et al., 2011; Farrington et al., 2012; Shechtman et al., 2013). Learning is a social activity that can be guided by teachers, but students also need to take responsibility for their own learning (Bandura, 1986; Yeager et al., 2014). Learning a growth mindset, developing grit, and demonstrating self-control could be used in the classroom as a way to improve attitudes, motivation, persistence, and behaviors. The noncognitive skills studied may be part of a solution for increasing mathematics achievement. The next section includes a detailed methodology of the research.

Section 2: The Methodology

Research Design and Approach

Despite ongoing efforts to improve curriculum and instruction, low mathematics achievement scores on the PARCC exam existed at an urban high school in New Jersey. The problem of this project study was a lack of information at the local site about the degree of prevalence of noncognitive skills and their relationship to mathematics achievement. The purpose of this study was to investigate the relationship between mathematics achievement and noncognitive skills. An experimental approach was considered because quantitative variables were studied. I decided against an experimental approach in favor of a nonexperimental approach due to the limitations of the survey instruments being used:

> On a cautionary note, we point out that these scales were originally designed to assess individual differences rather than subtle within-individual changes in behavior over time. Thus, we do not know whether they are valid indicators of pre- to post-change as a consequence of interventions. We also discourage the use of the scales in high stakes settings where faking is a concern. (The Duckworth Lab, n.d.)

Therefore, it was not the intent of this study to change or influence any variable with treatment, the goal was to be nonintrusive and analyze how noncognitive skills were related to mathematics achievement. A cross-sectional survey design was chosen for this study because more information was needed about the current state of noncognitive skills. Creswell (2012) stated "survey research designs are procedures in quantitative research in which investigators administer a survey to a sample or to the entire population of people to describe the attitudes, opinions, behaviors, or characteristics of the population" (p. 376).

Setting and Sample

The setting for this project study was an ethnically diverse urban high school in New Jersey that had a population of 1,843 students and 79% of them were considered economically disadvantaged. The ethnic breakdown was 37% Hispanic, 28% Black, 20% Asian, and 14% White (School Performance Report 2016-17, n.d.). A convenience sample was used to represent the population of all students at the high school. The goal was to know more about the relationship between noncognitive skills and mathematics achievement at the local setting, so a random sample of the population would have been ideal (Lodico, Spaulding, & Voegtle, 2010), but I was only permitted to visit groups of eligible students during the homeroom period. For this reason, I targeted as many homerooms as possible with the most eligible students.

Students that took the geometry PARCC exam during the 2016-17 school year were invited to participate so that a single achievement score could be used to measure mathematics achievement from one exam. The geometry PARCC exam was selected because most students that attend this high school took this course during their 9^{th}, 10^{th}, or 11^{th}-grade year, while some students take algebra 1 in 8^{th} grade and some students take algebra 2 in 12^{th} grade. This approached increased the chances of the participants having an available geometry PARCC score from the 2016-17 school year and still being enrolled at the local site during the 2017-18 school year. Students that were under 18 years were given an implied parental consent form to take home and get filled out and their own implied assent form. Students were able to provide their own implied consent if they were over 18 years old.

To exceed the minimum sample size for 80% power a large sampling frame was used. According to Cohen (1992), a correlation test with an α-level of .05 would need a sample size of 783 for a small effect size, 85 for a medium effect size, and 28 for a large effect size. To participate, students with existing archival geometry PARCC scores had to complete the three short noncognitive skills surveys online. The final sample size for the analysis was 97 students. According to Cohen (1992), a sample of 97 in a study of this type was estimated to have a medium effect size. Putting the sample size and effect size into G*Power software for a two-tailed test, the resulting power was 87% (Citea, 2014).

Instrumentation and Materials

Three self-report surveys were used to quantify the noncognitive skills mindset, grit, and self-control. Preestablished survey instruments were selected to quantify these noncognitive skills variables. Each measure produced a separate score for each student in the sample. The first was the Implicit Theories of Intelligence Scale for Children – Self Form, which quantified each student’s mindset and was obtained from her book *Self-Theories: Their Role in Motivation, Personality, and Development* (Dweck, 2000). The second was the 8-Item Grit Scale to quantify grit, and the third was the Domain-Specific Impulsivity Scale for Children to quantify self-control (The Duckworth Lab, n.d.). The grit and self-control surveys were available at The Duckworth Lab (n.d.), which is

Angela Duckworth's research website at the University of Pennsylvania. At this website, it stated that the scales can be used for research purposes. An email was also sent to the Duckworth Lab and the PERTS Lab at Stanford University to verify permission (See Appendix B). The PERTS Lab verified that Carol Dweck's scale could be used for research purposes as long as it was properly cited from her book (Dweck, 2000).

The instrument used to measure mindset in this study, Implicit Theories of Intelligence Scale for Children – Self Form (Dweck, 2000), has been used in many research studies. One study showed that students with an incremental theory of intelligence (growth mindset) got better mathematics grades than students with an entity theory of intelligence (fixed mindset), and it also concluded that teaching the incremental theory of intelligence to students reversed declining mathematics grades while the control group continued to decline (Blackwell, Trzesniewski, & Dweck, 2007). The study also showed that "the internal reliability of the theory measure was .78 in Study 1 (N = 373), with a mean of 4.45 and a *SD* of 0.97 (range 1-6). The test-retest reliability for this measure over a 2-week period was .77 (N = 52)" (Blackwell et al., 2007, p.249).

Duckworth et al. (2007) showed that people with more grit completed higher levels of education, had better grades at an Ivy League college, stayed in the military longer, and performed better in the National Spelling Bee using a grit survey. The instrument used to measure grit in this study, the 8-Item Grit Scale (The Duckworth Lab, n.d.), was developed and validated in 2009. The study suggested "that grit can reliably be assessed by informants. Internal consistency estimates for Grit-S ratings by family members, peers, and self were α = .84, .83, and .83 respectively" (Duckworth & Quinn, 2009, p.170). The instrument used to measure self-control in this study, Domain-Specific Impulsivity Scale for Children, was validated by Tsukayama, Duckworth, and Kim (2013). In this study it stated the "internal reliability coefficients for the Impulsivity Scale for Children and its subscales ranged from .63 to .95 (avg. = .86)" (Tsukayama et al., 2013, p.882).

Data Collection and Analysis

To recruit the participants I visited selected homerooms with the most eligible students and read a prewritten invitation script. The students were told they would only be eligible to participate if they took the geometry PARCC exam last year. Invitation letters were given to all students and contained the appropriate consent/assent forms based on the age of the individual. Students were asked to deliver forms to my classroom if they choose to participate and then they were emailed a survey to complete online. Survey data was collected online through the use of a Google form and the school email system. The data remained confidential by transferring and organizing the data to a Google sheet with no names or ID numbers attached to the data. I then linked survey data to mathematics achievement data as it was input to a Microsoft excel spreadsheet. There was no identifying information on the spreadsheets and the Google form surveys were deleted to make sure the data remained confidential.

A letter of cooperation from the school district was signed after conditional approval from the Institutional Review Board (IRB) was granted (Walden University IRB Approval Number: 10-31-17-0338192). Data were then transferred into the Statistical Package for Social Sciences (SPSS) for a quantitative analysis. Mindset, grit, and self-control were separate interval variables, which served as independent variables. Mathematics achievement was also an interval variable and served as the dependent variable. The statistical analysis for the first three research questions used a series of correlation tests to see if there was a relationship between the three noncognitive skills and mathematics achievement with a p-value of .05. The final three research questions used a series of regression tests to measure the extent that each noncognitive skill could predict mathematics achievement, also with a p-value of .05.

Assumptions, Limitations, Scope and Delimitations

Nonexperimental survey research is limited to identifying relationships between variables and will not establish causation. Establishing that there is or is not a relationship between noncognitive skills and mathematics achievement will be the first step in an attempt to address the larger problem of low mathematics achievement at an urban high school in New Jersey. If there is a relationship between noncognitive skills and mathematics achievement, a separate investigation would have to be done to better understand what causes that relationship. The scope of this study included noncognitive skills as measured by self-report survey instruments at this urban high school in New Jersey.

For ethical reasons, design decisions were made to protect the rights of participants which can limit the study. This research was limited to using confidential surveys to calculate noncognitive scores and available mathematics achievement data from the previous school year. Another limitation of this study was self-selection. Many eligible students were invited, but only students that returned consent/assent forms were able to participate. Self-selection may cause students with certain qualities to be the main representation of the sample, which can limit the generalization from the sample to the population (Creswell, 2012).

Protection of Participants' Rights

Necessary steps were taken to reduce potential harm to all participants in the study. The students were told about confidentiality and their ability to withdraw from the research at any time. Identification numbers were only connected to the survey data so that I could link noncognitive skills to mathematics achievement scores. Identification numbers were deleted after the survey data was linked to the mathematics achievement data. All data was stored on a laptop computer which is password protected and always locked in a storage closet when it is not in use. Data will be saved on the computer for five years and then deleted.

Data Analysis Results

After consent/assent forms were turned in, invitation emails were sent to eligible students. Survey data was collected for the noncognitive skills mindset, grit, and self-control, through the use of online surveys. The final sample size for the analysis was 97 students. According to Cohen (1992), a sample of 97 in a study of this type was estimated to have a medium effect size. Putting the sample size and effect size into G*Power software for a two-tailed test, the resulting power was 87% (Citea, 2014). First, the descriptive statistics were analyzed. There were 388 total students that had an eligible 2016-17 geometry PARCC score. The mean mathematics achievement score from the sample, 727, was slightly higher than the school's mean of 719. The mean mindset score was 4.4 out of 6, the mean grit score was 3.4 out of 5, and the mean self-control was 2.3 out of 5.

Table 5

Descriptive Statistics for Noncognitive Skills and Mathematics Achievement

	Mean	Standard Deviation	N
Mindset	4.3557	.87653	97
Grit	3.3724	.49967	97
Self-Control	2.3054	.86846	97
Math Achievement	727.0309	25.96931	97

Looking at the scatterplots for each noncognitive skill and mathematics achievement, the data appeared to be linear with no obvious curves or extreme outliers (See Figures 1, 2, & 3 below). The graphs show a small increase in math achievement as mindset and grit increased. There was a small decrease in math achievement as self-control increased.

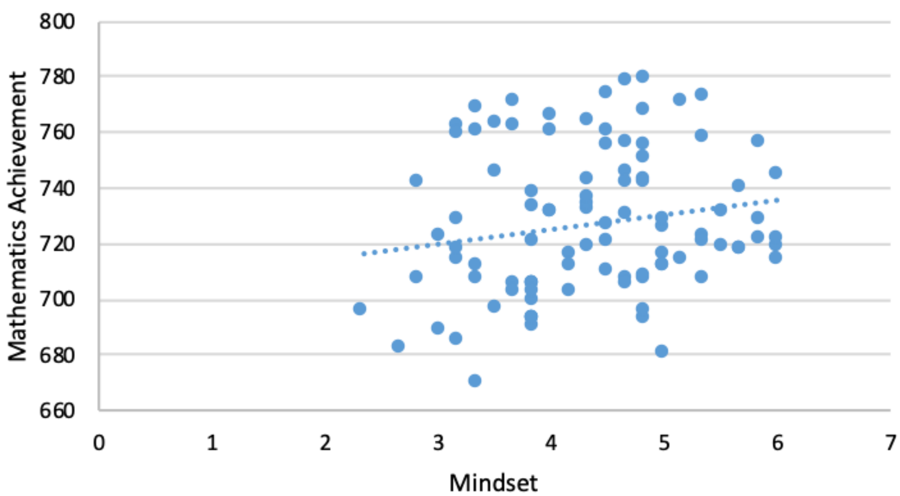

Figure 1. Relationship between mindset and mathematics achievement.

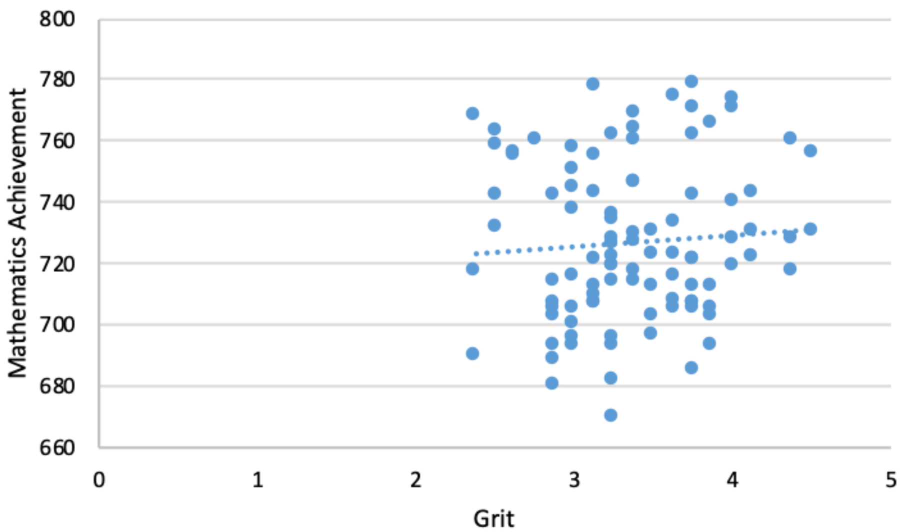

Figure 2. Relationship between grit and mathematics achievement.

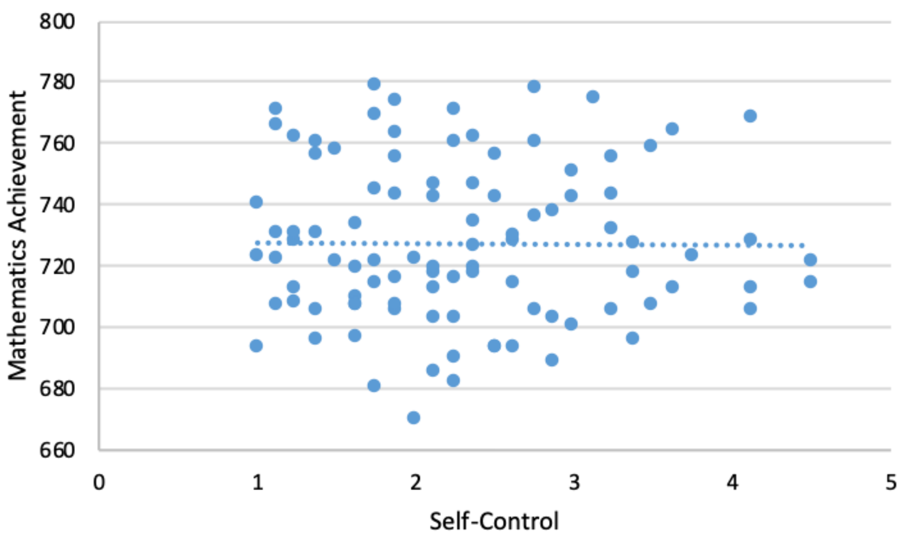

Figure 3. Relationship between self-control and mathematics achievement.

According to LAERD Statistics, a Pearson product-moment correlation value between .1 and .3 shows a small strength of association between the variables (Pearson Product-Moment Correlation, n.d.). The relationship between mindset and mathematics achievement was in the small association range, r = .1720. However, the relationship between grit and mathematics achievement was just below the small association range, r = .0700, and the relationship between self-control and mathematics achievement was very close to zero, r = -.0100. A correlation value close to zero indicates no association between the variables. Next, SPSS and Microsoft Excel were used to analyze the data with respect to each research question.

Table 6

Inferential Statistics for Noncognitive Skills and Mathematics Achievement

	R	R^2	F-Statistic	P-Value
Mindset	.1720	.0296	2.9026	.0917
Grit	.0700	.0049	.4725	.4935
Self-Control	-.0100	.0001	.0091	.9243

Research Question 1 was used to investigate: What is the relationship between academic mindset as measured by the Implicit Theories of Intelligence Scale and mathematics achievement as measured by the most recent geometry PARCC data? Since the significance value was .0917, which was greater than .05, I failed to reject the null hypothesis and concluded there was no relationship between academic mindset as measured by the Implicit Theories of Intelligence Scale and mathematics achievement as measured by the most recent geometry PARCC data. There was marginal evidence of a relationship between mindset and mathematics achievement, but the data lacked statistically significant evidence at the .05 level.

Research Question 2 was used to investigate: What is the relationship between academic perseverance as measured by the Grit Scale and mathematics achievement as measured by the most recent geometry PARCC data? Since the significance value was .4935, which was greater than .05, I failed to reject the null hypothesis and concluded there was no relationship between academic perseverance as measured by the Grit Scale and mathematics achievement as measured by the most recent geometry PARCC data. There was very little evidence of a relationship between grit and mathematics achievement.

Research Question 3 was used to investigate: What is the relationship between academic perseverance as measured by the Self-control Scale and mathematics achievement as measured by the most recent geometry PARCC data? Since the significance value was .9243, which was greater than .05, I failed to reject the null hypothesis and concluded there was no relationship between academic perseverance as measured by the Self-control Scale and mathematics achievement as measured by the most recent geometry PARCC data. There was no evidence of a relationship between self-control and mathematics achievement.

Research Question 4 was used to investigate: To what extent can academic mindset as measured by the Implicit Theories of Intelligence Scale predict mathematics achievement as measured by the most recent geometry PARCC data? Since the significance value was .0917, which was greater than .05, I failed to reject the null hypothesis and concluded there was no significant linear relationship between academic mindset as measured by the Implicit Theories of Intelligence Scale and mathematics achievement as measured by the most recent geometry PARCC data. A small association was present between mindset and mathematics achievement, but only 3% of the variation in mathematics achievement could be accounted for by the linear model.

Research Question 5 was used to investigate: To what extent can academic perseverance as measured by the Grit Scale predict mathematics achievement as measured by the most recent geometry PARCC data? Since the significance value was .4935, which was greater than .05, I failed to reject the null hypothesis and concluded there was no significant linear relationship between academic perseverance as measured by the Grit Scale and mathematics achievement as measured by the most recent geometry PARCC data. Only .5% of the variation in mathematics achievement could be accounted for by the linear model.

Research Question 6 was used to investigate: To what extent can academic perseverance as measured by the Self-control Scale predict mathematics achievement as measured by the most recent geometry PARCC data? Since the significance value was .9243, which was greater than .05, I failed to reject the null hypothesis and concluded there was no significant linear relationship between academic perseverance as measured by the Self-control Scale and mathematics achievement as measured by the most recent geometry PARCC data. Only .01% of the variation in mathematics achievement could be accounted for by the linear model.

The theoretical framework of this study suggested there are both internal and external factors that influence learning (Bandura, 1986). The three selected noncognitive skills were just a small part of the internal factors that influence mathematics achievement for the students at this urban high school in New Jersey. Dweck's (2010) work on academic mindsets suggested that students with a growth mindset would be more willing to learn and result in higher academic achievement. This was to some extent verified by the results of this study because math achievement had a small positive association with mindset scores. For the two academic perseverance skills, grit showed very little association with mathematics achievement, and self-control showed no association with mathematics achievement for this sample of students at the urban high school in New Jersey.

A study found that grit was a common quality of people who stayed in the military, held jobs for longer periods of time, graduated from high school, and had longer marriages (Eskreis-Winkler et al., 2014). These researchers focused on life outcomes and did not focus on achievement scores. At the urban high school in New Jersey, the data showed that grit had very little association with mathematics achievement. Another study showed causation between self-control and GPA, but also did not focus on achievement scores (Duckworth et al., 2010). At the urban high school in New Jersey, the results showed no association between self-control and mathematics achievement.

Garcia (2014) noted that there has been a long history of data that showed a positive correlation between noncognitive skills and various life outcomes. For this reason, they are important to teach as a skill to help students later in life, regardless of the relationship with achievement scores. Another study by West et al. (2016) showed that noncognitive skills had a positive correlation with attendance, behavior, and achievement score gains from 4^{th} to 8^{th} grade in math and ELA. The results confirmed that noncognitive skills can be related to many positive school and life outcomes, but they may only have a subtle effect that can result in achievement gains for some populations.

Farrington et al. (2012) did a review of the literature and suggested that noncognitive skills work in a hierarchy starting with academic mindsets, then to academic perseverance, then to academic behaviors, and finally to academic achievement. Similarly, Garcia (2014) argued that noncognitive skills support cognitive development that leads to high achievement levels. Their findings were not consistent with the data collected at the urban high school in New Jersey for mathematics achievement. It is possible that the local high school was unique because it has a very high poverty rate and very low mathematics achievement scores.

A study by Borghans, Golsteyn, Heckman, & Humphries (2016) confirmed that personality was better than IQ at predicting grades and life outcomes. The study also found that IQ was better than personality at predicting achievement scores (Borghans et al., 2016). Low mathematics achievement starts early in life and usually continues to be a problem in schools located in low socio-economic neighborhoods (Graham & Provost, 2012; Reardon, 2013; Sonnenschein & Galindo, 2014; Watts et al., 2014). The urban high school in New Jersey had very low mathematics achievement scores with only 16.4% proficiency rate and a very high economically disadvantaged rate of 79% (School Performance Report 2016-17, n.d.).

West et al. (2016) suggested that survey responses can be subjective to social context. For example, students filling out noncognitive skills surveys may respond to what they think they should be in school, instead of a reflection of their true behaviors. It is also possible that students have the internal motivation to do well, but lack the external support. In a study by Cragg & Gilmore (2014) executive function, or working memory, was found to be a necessary skill for learning new mathematics concepts. In a low performing and high poverty school district, there tends to be many students that bring distractions to school with them (Wanless et al., 2011). Without a structured and supportive learning environment focused on needs, even students that want to do well may still struggle to learn new mathematics concepts (Schoenfeld, 2014).

Since the three noncognitive skills did not have statistically significant relationships with mathematics achievement, the project deliverable for this study was a policy recommendation. The findings suggested that there was only a small association between academic mindset and mathematics achievement at the local site. Based on those results and The National Council of Teacher of Mathematics (NCTM) positions, I will be recommending a more comprehensive and evaluative intervention approach to address low mathematics achievement at the urban high school in New Jersey. A specific focus on any noncognitive skill will not benefit all students, so various interventions should be used to target specific student needs through the use of formative assessments (Garcia et al., 2015; Killion & Roy, 2009; Marzano, Heflebower, Hoegh, Warrick, & Grift, 2016; National Council of Teachers of Mathematics, 2011).

The resulting project for this study was a policy recommendation that included redefining the role of teacher leaders, adding mathematics specialists, and improving the use of formative assessments. The policy needs to support a collective and sustained intervention effort throughout the district that includes increasing pedagogical knowledge for teachers. The recommendations included increasing the number of mathematics specialists throughout the district to help support instruction and student learning (National Council of Teachers of Mathematics, 2010). It is important to address low achievement early in the process before students fall too far behind (Watts et al., 2014). The next section will describe the details of the project.

Section 3: The Project

Introduction

Despite ongoing efforts to improve curriculum and instruction, low mathematics achievement scores on the PARCC exam existed at an urban high school in New Jersey. The purpose of this study was to investigate the relationship between nonognitive skills and mathematics achievement. In Section 2, the data showed no statistically significant relationship between the three selected noncognitive skills and mathematics achievement. These findings led me to the conclusion that specific noncognitive skill interventions are not the best approach to improving overall mathematics achievement. Based on these findings and the NCTM positions, I will be submitting a policy recommendation to key stakeholders.

The recommendations were a more comprehensive and evaluative intervention approach that includes redefining the role of teacher leaders, adding mathematics specialists, and improving the use of formative assessments (National Council of Teachers of Mathematics, 2010; National Council of Teachers of Mathematics, 2011). The goal of this policy recommendation was to inform school and district leadership of the most current and research supported practices that will help lead to an increase in future mathematics achievement. This goal will be evaluated by observing changes in policies and monitoring future mathematics achievement scores in the district.

The high school leadership team includes the principal and four vice principals. The district leadership team includes the superintendent, the assistant superintendent, the director of secondary education, the director of elementary education, the director of special projects and assessments, and the director of student services and special education. Even though this project study originally focused on a high school population, the resulting project deliverable has the potential to benefit all grade levels in the district, so it was shared with both the high school and district leadership teams. It would be best if the policy changed districtwide because research showed that the most cost-effective interventions occur at the youngest grade levels before achievement gaps have the time to grow (Galindo & Sonnenschein, 2015; Reardon, 2013).

Rationale

Results from my study showed that noncognitive skills such as mindset, grit, and self-control have little to no association with mathematics achievement at the urban high school in New Jersey. A more comprehensive and evaluative intervention approach across the entire school district would be a better strategy for improving mathematics achievement (National Council of Teachers of Mathematics, 2010; National Council of Teachers of Mathematics, 2011). Recently, the urban high school in New Jersey has gone through budget cuts that resulted in the loss of staff, including instructional supervisors. This transition has resulted in more responsibilities for administrators and new roles called teacher leaders. Additionally, PLCs were implemented to guide the professional development process. Assigned teacher leaders for each department are now responsible for planning meetings, implementing PLC activities, and monitoring the professional development for all teachers in their department.

While some teachers at the high school are improving under the new collaborative leadership model, it is possible that others are unwilling to adapt. In a PLC, teachers should collect and use data to identify weaknesses so that improvements and interventions can take place (Garcia et al., 2015; Killion & Roy, 2009). It is possible that there is a lack of knowledge and guidance for teacher leaders in the district to appropriately guide the formative assessment cycle due to a lack of instructional supervisors. Restructuring the leadership responsibilities and starting the PLC process are two big endeavors to take on simultaneously. At the urban high school in New Jersey, it is unclear how well these collaborative teams are functioning because there is a lack of evaluation in the process. When implementing big transitions it is crucial to invest support where it is needed and track progress to sustain growth (Garcia et al., 2015).

In the book *Collaborative Teams that Transform Schools*, the authors described the need for second-order change when shifting from traditional teaching methods to more collaborative methods (Marzano et al., 2016). Second-order change requires support from all stakeholders and highly skilled leadership to guide the process (Marzano et al., 2016). At the urban high school in New Jersey, the administrators are understaffed and sharing leadership responsibilities with teachers. A shared leadership model will only work if those teacher leaders are properly trained and highly motivated to transform the school. There are currently two new leadership styles being implemented simultaneously, transformative and shared. While both styles are attainable and can coexist, it will require a change in the current policy, which was why a policy recommendation, also called a white paper, was an appropriate choice for the project.

Review of the Literature

The review of the literature was compiled using Google scholar and various Walden library educational databases. The databases included ERIC, Educational Research Complete, and SAGE Premier. The main search terms included: *white papers, policy recommendations, educational leadership, mathematics, mathematics interventions, mathematics specialists, student achievement, school interventions*, and *classroom interventions*. This section synthesized the literature related to the white paper by using the following headings: The White Paper, School-Level Interventions, and Classroom-Level Interventions.

The White Paper

The results from Section 2 lacked statistical significance to conclude a noncognitive skill intervention plan would be beneficial to the students at the urban high school in New Jersey. These findings led me to the conclusion that specific interventions are not the best approach to improving overall mathematics achievement for all students. After researching for alternative project ideas, the resulting project deliverable was a policy recommendation, which is also called a white paper. The NCTM does not endorse a specific intervention strategy, but instead recommends constant formative assessment to address the individual needs of students (National Council of Teachers of Mathematics, 2011). The policy recommendations will help guide district leadership in the right direction to increase future mathematics achievement at the urban high school in New Jersey.

The white paper followed the format outlined by Mattern (2016): the problem, proof the problem exists, additional problems, and the solution. The recommendations were focused on increasing overall mathematics achievement. Stelzner (2007) explained that white papers are appropriate when trying to influence decision-makers that a change is necessary. It is important to know the audience, which is the school and district leadership teams, and grab their attention that a change in policy is needed (Stelzner, 2007). Teachers have increased the use of data throughout the district, but are lacking knowledge and direction. The selected teacher leaders possibly lack formal training with varying levels of content and pedagogy knowledge. Policy changes that have a more comprehensive and evaluative intervention approach, supported by mathematics specialists, would improve the formative assessment and collaboration process.

Recent budget cuts at the urban high school in New Jersey have resulted in major shifts to professional development practices. Teacher leaders now take on most of the responsibility of guiding PLC practices within each department instead of instructional supervisors. This was a big change in policy that lacked some important supports that are necessary when attempting to transform a school. Tracking and changing the culture from the bottom up is an important component to sustainable improvement (Fullan & Pinchot, 2018). According to Quin, Deris, Bischoff, and Johnson (2015), transformational leaders in high performing schools generate stakeholder support by setting clear standards towards a common vision. Currently, at the urban high school in New Jersey, each department has their own vision and it is unclear if progress is being made. Some additional adjustments to the current policy could help support the endeavor to improve instruction through shared leadership practices.

Effective school leadership has evolved over the years from a top-down model to a more collaborative approach (Marx, 2006). "A growing body of research shows that collaboration between teachers and administrators – not confrontation – improves student outcomes" (Anrig, 2015, p.30). At the urban high school in New Jersey, the PLC process was just beginning and each department was in various stages of progression. It would really benefit the school if there were more instructional leaders who could focus on monitoring instruction and guiding professional development. It would also benefit the entire district to add mathematics specialists, which are highly skilled in content and pedagogical knowledge, to guide the intervention and collaboration processes of effective PLCs (National Council of Teachers of Mathematics, 2010; National Council of Teachers of Mathematics, 2011).

Policy decisions should start with a cost-benefit analysis that can provide valuable information to policymakers. By establishing standards and having consistent evaluations it will become clearer why mathematics achievement at the urban high school in New Jersey has remained stagnant (Levin & Belfield, 2015). By adding mathematics specialists, these evaluations can be performed consistently in all schools and provide first-hand information about the professional development needs of teachers. The new mathematics specialists could also spend more time in the classroom collaborating with teachers. This would help them better understand instructional needs and design more targeted professional development activities (Bayar, 2014). Adding mathematics specialists would be an initial upfront cost that can provide many future benefits.

School-Level Interventions

The results from Section 2 showed that noncognitive skills such as mindset, grit, and self-control, had little to no relationship with mathematics achievement at the urban high school in New Jersey. Therefore, the resulting project was a white paper that made policy recommendations to the school and district leadership teams that included school-level changes to support the overall intervention efforts. Supporting teachers' professional development is an important step towards improving mathematics achievement. Killion and Roy (2009) suggested a shift in professional development from outside-in to inside-out learning, which promotes collaboration among teachers to set their own goals and track their own progress. Similarly, Guskey (2014) supported the idea of backward planning, which starts with the end result in mind when planning professional development. The addition of mathematics specialists would help guide this process because they would be able to spend time collaborating with teachers.

Analyzing meaningful school-level data only once a year limits the number of adjustments that can be made to improve curriculum, instruction, and assessments. Formative assessments should be used on a regular basis to target specific student needs and monitor school goals (Garcia et al., 2015; Killion & Roy, 2009). Cycles of formative assessment should be constant and ongoing in every classroom throughout a school. According to de Boer, Donker, and van der Werf (2014), interventions should be short and measured with an unstandardized test. Sarama and Clements (2015) criticized the use of standardized assessments in our schools and suggested that a focus on getting the most kids to pass can actually widen the achievement gap between low and high-income schools.

Socioeconomic mathematics achievement gaps observed in high school start before students enter school (Watts et al., 2014). Reardon (2013) showed that this gap does not always continue to grow as students progressed through school, and suggested the most effective interventions take place in the earliest grades before the gaps get too wide. Galindo and Sonnenschein (2015) agreed, their research found that addressing deficiencies in kindergarten was the most effective strategy for decreasing socioeconomic mathematics achievement gaps. Early intervention and sustained support are important for supporting economically disadvantaged students. Dietrichson, Bøg, Filges, and Jørgensen (2017) suggested supporting low socioeconomic students with tutoring, feedback, progress monitoring, and cooperative learning.

Language arts skills are a major focus of early education and mathematics may be losing some necessary attention. Anders and Rossbach (2015) discussed the importance of mathematics when preschool children play and suggested that a teacher’s pedagogical beliefs can determine the level of mathematical content. In a review of early numeracy interventions, children from age four to seven showed improved mathematics achievement later in life compared to control groups (Mononen, Aunio, Koponen, & Aro, 2014). These studies suggested that improving pedagogy and interventions in early education was a wise approach to addressing future mathematics achievement gaps.

School-level interventions should not be about one specific program or initiative that everyone has to follow, it should be about providing resources for support that benefit student learning. In a study that investigated school-wide reform models, students showed increased mathematics scores over comparison schools by focusing on reorganizing school resources, social/behavioral development, data-driven problem solving, family engagement, and district-level support (Choi, Meisenheimer, McCart, & Sailor, 2016). In another study by Ottmar, Rimm-Kaufman, Larsen, and Berry (2015), social and emotional supportive classrooms led to better mathematics instruction and improved mathematics achievement. These studies showed the importance of support systems being in place when students need them to assist teacher instruction and student achievement.

Using technology for interventions has become more common over the years. Research showed that computer-based interventions can be an effective and efficient approach to remediation for fourth and fifth-grade students (Kanive, Nelson, Burns, & Ysseldyke, 2014). Computer-based intervention programs have also been shown to increase mathematics achievement for low-income preschoolers (Schacter & Jo, 2016). Roschelle, Feng, Murphy, and Mason (2016) studied online homework support for seventh graders and found that students scored higher on the standardized mathematics assessment at the end of the year. There are numerous computer-based programs that can guide or support mathematics instruction, and these programs can make it easier for teachers to differentiate their lessons based on student needs.

Students that are behind their peers can sometimes act out and disrupt the classroom learning environment. Staff buy-in, administrator support, and consistency were three factors identified in a study about school-wide behavior interventions (Pinkelman, McIntosh, Rasplica, Berg, & Strickland-Cohen, 2015). Some students need a specialized or creative intervention to help them function in school. Waters, Barsky, Ridd, and Allen (2015) reviewed 15 studies on the effects of meditation interventions. Their findings led to a conceptual framework that concluded meditation can help students succeed by developing emotional regulation (Waters et al., 2015). Interventions are necessary to stop achievement gaps from widening and they should be tailored to the specific needs of each population.

Mathematics achievement has a positive correlation with teachers' mathematical content knowledge and teachers' pedagogical knowledge (Campbell et al., 2014). In an ideal world, teachers at all grade levels would be highly qualified in mathematics and become better teachers every year. Professional development is an important part of developing better teachers and mathematics coaches should be used to help aid the process. In a study on coaching, teachers that received more feedback were more likely to implement new pedagogy and more proactive classroom management (Reinke, Stormont, Herman, & Newcomer, 2014). Elementary mathematics specialists are supported by the NCTM, the Association of Mathematics Teacher Educators, the Association of State Supervisors of Mathematics, and the National Council of Supervisors of Mathematics (National Council of Teachers of Mathematics, 2010).

Classroom-Level Interventions

The results from Section 2 suggested that noncognitive skill interventions such as mindset, grit, and self-control, would have little to no effect on improving mathematics achievement at the high school level. The resulting project was a white paper that made policy recommendations to the school and district leadership teams which includes classroom-level changes to support the daily intervention efforts of teachers. According to Garcia et al. (2015), decisions based on data should be used to reflect and adjust the efforts to meet learning targets throughout the school year. Focusing on meaningful instructional cycles will help teachers avoid the pitfalls of data-driven instruction, which can include teaching to the test and viewing students as numbers instead of individuals (Neuman, 2016).

When teachers are deciding which interventions to use it is important to let data drive the process, this method has been shown to be especially effective in low socioeconomic schools (Geel, Keuning, Visscher, & Fox, 2016). Implementing interventions in an attempt to reduce achievement gaps is not a simple task, it is an ongoing challenge. Social and psychological interventions have been shown effective in many studies, but Spitzer and Aronson (2015) explained that they do not address structural barriers, so they may not work with all populations. In a review of the research on executive function, there was a moderate association with mathematics achievement but a lack of causal evidence (Jacob & Parkinson, 2015). There are many noncognitive and cognitive factors that are indicators of future success, but they are not quick fixes to our achievement gaps.

How each teacher manages their classroom is an important part of the collective efforts to increase achievement scores. In a study about active learning compared to traditional lecturing in mathematics, results showed an increase in exam scores and a decrease in failing grades (Freeman et al., 2014). In another study by Firmender, Gavin, and McCoach (2014), there was a positive relationship between the instructional decisions teachers made and mathematics achievement. How mathematics instruction is being delivered to students should be continuously monitored by a skilled professional that has the appropriate content and pedagogy knowledge (National Council of Teachers of Mathematics, 2010).

Instructional decisions made by the teacher can set the tone for the classroom environment which can greatly affect student performance. Keeping students motivated throughout the school year is an important factor in a positive classroom environment which can be established and sustained through instructional activities (Lin-Siegler, Dweck, & Cohen, 2016). Teachers can plan specific activities to motivate, but it is also important to constantly praise students for their efforts, not their accomplishments, so they develop a growth mindset (Dweck, 2006). Gilbert et al. (2014) concluded that there was a positive relationship between student perceptions of their teacher's confidence in them and their ability to master mathematical concepts.

By the time students get to high school age, there tends to be less focus on motivation and more focus on content. The NCTM recommends the focus of high school mathematics should be reasoning and sense-making to keep students interested and prepare them for the transition to becoming productive citizens (National Council of

Teachers of Mathematics, n.d.). Similarly, León, Núñez, and Liew (2015) suggested making mathematics lessons more meaningful to high school students to help them stay engaged. Connecting mathematics to the real world and focusing on applications is beneficial to high school students, especially if they struggle with motivation.

Another barrier for teachers to overcome in the classroom is math anxiety. Beilock and Maloney (2015) suggested that math anxiety contributes to the lack of STEM graduates ready for the workforce and teachers need to be aware of this phenomenon. Our national perceptions of mathematics and attitudes towards it may be contributing to the low international scores observed on the PISA (Desilver, 2017). Another study showed that students with the most cognitive potential avoided using advanced problem-solving strategies if they had mathematics anxiety, bringing their achievement level down to their lower cognitive functioning peers (Ramirez, Chang, Maloney, Levine, & Beilock, 2016). There are many people that simply hate math or accept the fact that they are not good at it, but we need to recognize these types of problems in students and be prepared with the appropriate interventions.

Project Description

The project deliverable was a white paper that will be presented at a faculty meeting at the urban high school in New Jersey to share it with as many stakeholders as possible. The principal, vice principals, and teachers will be in attendance. I will also invite the district leadership team to this faculty meeting. Potential barriers include getting on the agenda for the faculty meeting. My presentation for the meeting will be a slide show that highlights the main points of my white paper. The principal has agreed to put me on the agenda after reviewing my presentation. The presentation and white paper will be emailed to all school and district leadership members after the meeting. I also plan to present at a future school board meeting and parent advisory committee meeting to share my research with as many stakeholders as possible.

Project Evaluation Plan

I will evaluate the project by using various formative assessments so that adjustments can be made throughout the process. Getting district policy to change in hopes of increasing mathematics achievement at the high school level is a very ambitious and long-term goal that will require lots of formative data. Garcia et al. (2015) explained that formative assessments are necessary for the classroom and also stated that “part of any goal-setting process is assessing incremental progress toward the final target” (p.79). The project will be evaluated initially by the reaction of the high school and district leadership teams after the white paper has been presented and emailed to them. This is an appropriate initial assessment because I will be able to observe their reaction and take additional future action if necessary. One action could be surveying district staff to analyze their specific professional needs and presenting those findings to the district leadership team. Another action could be to continue having conversations with all stakeholders to help drive the best solutions for increasing mathematics achievement.

My goal for this project is to be part of the solution for increasing mathematics achievement. I have written a white paper to suggest some current options we have, but it will take the actions of many to achieve this vision. To increase mathematics achievement there must be an improvement to the evaluative efforts to know what is working and what needs to be improved. Monitoring interventions and various forms of performance data will be the best way to make future decisions. I will continue to work with the key stakeholders to suggest and support any changes to policy that will influence future increased mathematics achievement as well as an associated evaluation strategy for each. The key stakeholders that would oversee these changes are the district leadership team which includes the superintendent, the assistant superintendent, the director of secondary education, the director of elementary education, the director of special projects and assessments, and the director of student services and special education.

Project Implications

Low mathematics achievement is a problem for many school districts in our country. This project has the potential to influence policy change that will lead to an increase in mathematics achievement at the urban high school in New Jersey. This would definitely be positive social change to the school and the entire community. Higher achievement scores would help the image of the school and the self-esteem of all community members. The urban high school in New Jersey has had low achievement scores for a long time and the cyclical process makes it more difficult for the next generation to break that cycle. Through the use of various school-level and classroom-level interventions, mathematics instruction can be improved (National Council of Teachers of Mathematics, 2011). Many urban schools score much lower than suburban schools and changing this trend would be a major accomplishment.

It is also possible that with higher mathematics achievement scores more students would pursue STEM fields in college and in the workforce. Addressing the lack of

STEM graduates ready for the workforce at the local level is the first step in reversing the national trend (Beilock & Maloney, 2015). Improved mathematics achievement at the urban high school in New Jersey will help us expand the current STEM programs from enrichment to a regular part of the curriculum. Enhancing STEM programs is a necessary progression due to the New Jersey Next Generation Science Standards that inspire to have additional training for teachers to offer more STEM related courses (New Jersey Next Generation Science Standards, n.d.). The state and national effort to increase the number of STEM graduates can only be successful if local school districts start to change policy to improve mathematics instruction at the local level. The resulting project deliverable from this study will help change policy that could improve mathematics instruction and prepare more STEM graduates.

Section 4: Reflections and Conclusions

Project Strengths and Limitations

Despite ongoing efforts to improve curriculum and instruction, low mathematics achievement scores on the PARCC exam existed at an urban high school in New Jersey. The purpose of this study was to investigate the relationship between noncognitive skills and mathematics achievement, but the results from Section 2 did not show statistically significant evidence for any of the selected skills. Therefore, the resulting project was a white paper that recommended a more comprehensive and evaluative intervention approach in the efforts to increase mathematics achievement. The white paper was written to recommend redefining the role of teacher leaders, adding mathematics specialists, and improving the use of formative assessments (National Council of Teachers of Mathematics, 2010; National Council of Teachers of Mathematics, 2011).

The main strength of this project deliverable is the potential to increase mathematics achievement. Guided by the results of this study and the positions of the NCTM, there are three usable recommendations that can be implemented. Another strength of this project was the inside information being provided from an experienced educator that works in the trenches on a daily basis. These recommendations came about through the reflection process of a high school mathematics teacher that has been in the district for thirteen years and has spent a lot of time researching these topics. Other strengths of this project include the potential to increase collegiality among staff and the potential to improve school culture.

This project was limited to recommendations being made by a teacher leader. In Section 3, a plan was described that included presenting the recommendations at a faculty meeting and emailing the white paper to the school and district leadership teams. The next step will be to follow up with everyone on those leadership teams and have discussions about changing the current policies. Those discussions will continue with as many stakeholders as possible. This project was limited to information for decision makers to consider and will only result in policy change if enough stakeholders are convinced. While I am optimistic that my recommendations are helpful, I realize that my project has these limitations. Evidence of future interventions should be carefully examined to see if the changes in policy are effective. Such evidence-based decision making can inform policy and drive strategic change. This is a strength that may yet evolve from the limitations and results of my study.

Recommendations for Alternative Approaches

This project study used a nonexperimental approach to measure the relationship between noncognitive skills and mathematics achievement. A correlational study was appropriate because there was limited data available on noncognitive skills at the urban high school in New Jersey. An alternative approach that could have been used was a qualitative study instead of quantitative. By focusing on a smaller sample size, I would have been able to dig deeper into the details of each student. Understanding why some students have lower noncognitive skills would have addressed the problem of low mathematics achievement from a different perspective. This alternative approach would have been more targeted and only benefitted some of the students instead of addressing the overall mathematics achievement problem.

Scholarship, Project Development and Evaluation, and Leadership and Change

This project started with a problem of low mathematics achievement at an urban high school in New Jersey. There was an established history of low achievement data, but only limited data available that suggested a lack of noncognitive skills. These data included low graduation rates and high suspension rates. As a teacher in this district, I suspected that a lack of noncognitive skills was contributing to the problem, but there was no specific data yet available to make that conclusion. After using preestablished instruments to collect data on mindset, grit, and self-control, the results showed no statistically significant evidence of a relationship between noncognitive skills and mathematics achievement. These results were not what I expected, but as a researcher, I learned not to let my assumptions guide my decisions.

The results ultimately led to a policy recommendation that was guided by the research process. The combination of examining available data, identifying the problem, reading the literature, collecting data, and analyzing the results, has taught me a lot about leadership and change. As a future leader, I now know that it is important to understand every aspect of a problem before implementing a solution. The research suggested many practices for school districts to consider, but it is up to the local policymakers to investigate and determine what is best for their students. Assumptions that I had made about noncognitive skills before this project, may have led me to make rash decisions as a future leader. This process has helped prepare me for future leadership challenges in education that do not have simple solutions.

Reflection on Importance of the Work

I have learned that there are many variables that can impact mathematics achievement. The theoretical framework of this study was Bandura's social cognitive theory, which suggested that humans are complex beings that are constantly influenced by internal and external factors. Noncognitive skills are just some of the many internal factors that influence student achievement. While a noncognitive skill intervention may have benefited some students, it may have done very little for others. Teachers are just one, but a very important external factor that influence achievement for all their students. As educators, we need to constantly evaluate the needs of our students and modify instruction to best support those needs (National Council of Teachers of Mathematics, 2011). These daily interventions that effective teachers provide are necessary because they can help establish and sustain higher student achievement.

Implications, Applications, and Directions for Future Research

The recommended changes in policy have the potential to increase overall mathematics achievement at the urban high school in New Jersey. These recommendations include redefining the role of teacher leaders, adding mathematics specialists, and improving the use of formative assessments (National Council of Teachers of Mathematics, 2010; National Council of Teachers of Mathematics, 2011). These changes can help teachers improve instruction, which would be a direct benefit to the school. Improving instruction would have a positive influence on the students because they would have more opportunities available to them after high school. Over time, benefiting the students can help improve the image of the community and lead to positive social change.

The policy recommendations in the white paper are supported by the positions of the NCTM and recent educational research. It is important to have this knowledge when changing policy and it is imperative to share this information with members throughout the organization. Having all stakeholders believe that change is needed can sometimes be the most difficult part of school improvement efforts (Fullan & Pinchot, 2018). Leadership throughout the school district should help build and maintain a positive school culture that is focused on continuous improvement. This process should include research to investigate potential solutions to their future challenges to improve the school for all stakeholders.

Conclusion

A lot was learned about the relationship between noncognitive skills and mathematics achievement at the urban high school in New Jersey. While a noncognitive skills intervention may have been beneficial to a certain class or some students, it is not the best approach for the entire school. It is more important for leadership to focus on the policies that influence teachers to make daily decisions in the classroom that are best for all of their students. By empowering educators to use formative data to drive instructional decisions they will be addressing the changing needs of our students. There is no magic intervention strategy that is going to fix mathematics achievement for all students throughout a school, but we can focus on improving policies that will lead to various interventions. By evaluating the comprehensive intervention efforts we will know which strategies are most effective. Like many challenges in life, there is no quick fix, but a sustained and unified effort can help improve mathematics achievement.

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Appendix A: The Project

The Problem

Despite ongoing efforts to improve curriculum and instruction, low mathematics achievement scores on the Partnership for Assessment of Readiness for College and Careers (PARCC) exam existed at an urban high school in New Jersey. Only 16.4% of the students were meeting standards, which was very low compared to the state average of 43.5% (School Performance Report 2016-17, n.d.). It has been well documented in the research that low-income students perform lower on standardized assessments, but this should not be an accepted occurrence by educational institutions (Garcia, 2015; Reardon, 2013). At this target urban high school in New Jersey, 79% of the students were considered economically disadvantaged (School Performance Report 2016-17, n.d.). Economically disadvantaged students score lower on average, but there are some students that perform well on state assessments regardless of socioeconomic status. One possible explanation of overcoming these obstacles is noncognitive skills.

To help address the low mathematics achievement a better understanding of the noncognitive skills academic mindset and academic perseverance is needed. Noncognitive skills have been called "soft skills" by some researchers because they are related to human constructs that are difficult to quantify in any way except self-reported survey responses (Heckman & Kautz, 2012). Education has a history of solely evaluating students and teachers by achievement scores, which may be a limited view (Shechtman, DeBarger, Dornsife, Rosier, & Yarnall, 2013). As a mathematics teacher at this urban high school in New Jersey, I suspected that motivation and perseverance were major problems for our students. It seemed like a lot of our students simply did not care about education and there was little that we could do to change their attitudes towards mathematics. My research study examined the prevalence of the noncognitive skills mindset, grit, and self-control, to determine whether or not there was a relationship with mathematics achievement.

Proof the Problem Exists

According to recent data at an urban high school in New Jersey, there has been some school-wide improvement in overall mathematics achievement. The mathematics proficiency level on the New Jersey High School Proficiency Assessment (NJHSPA) was at 59% for the 2011-12 school year (School Performance Report 2011-12, n.d.). The percent proficient increased to 67% for the 2012-13 school year and increased again to 73% for the 2013-14 school year (School Performance Report 2012-13, n.d.; School Performance Report 2013-14, n.d.). These improving scores were encouraging to the mathematics department at the high school because a lot of improvement efforts were implemented during those years.

Table A1

Mathematics Section of the NJHSPA at an Urban High School in New Jersey

	11-12	12-13	13-14
Percent Proficient on NJHSPA	59%	67%	73%

During the 2014-15 school year, the state assessment switched from the NJHSPA to the PARCC exam. These data were analyzed separately because it was a different exam based on the more rigorous Common Core State Standards (CCSS). As shown in Table 2 below, the first three years of PARCC data indicated that school-wide mathematics achievement was very low and not increasing as rapidly as it did the previous three years on the NJHSPA (School Performance Report 2014-15, n.d.; School Performance Report 2015-16, n.d.; School Performance Report 2016-17, n.d.). The NJHSPA was a single exam that students took during their junior year, but the new PARCC exam evaluated each student on a yearly basis for the courses algebra 1, geometry, and algebra 2.

Table A2

Mathematics Section of the PARCC at an Urban High School in New Jersey

	14-15	15-16	16-17
Percent Met/Exceeded Expectations on PARCC	14%	15%	16%

Local data had focused predominantly on mathematics achievement without much attention to noncognitive skills. Some researchers have recognized that academic behaviors, such as grades and credits, can be indicators of noncognitive skills (Duckworth, Quinn, & Tsukayama, 2012; Farrington et al., 2012; Kautz & Zanoni, 2014). Low noncognitive skills can lead to poor academic behaviors, which can lead to bad grades and a lack of credits. Failing courses and not obtaining enough credits each year eventually leads to lower graduation rates. The graduation rate at the urban high school in New Jersey had improved over the last six years, but the most recent available data showed it was still well below the state average of 90.5% (School Performance

Report 2011-12, n.d.; School Performance Report 2012-13, n.d.; School Performance Report 2013-14, n.d.; School Performance Report 2014-15, n.d.; School Performance Report 2015-16, n.d.; School Performance Report 2016-17, n.d.).

Table A3

Graduation Rate at an Urban High School in New Jersey

	11-12	12-13	13-14	14-15	15-16	16-17
Graduation Rate	70%	67%	70%	74%	76%	81%

Suspension rates can also be related to noncognitive skills, especially the academic perseverance skill self-control (Zimmerman & Kitsantas, 2014). Over the past six school years, the percent of students that had been suspended at least one time varied, and the most recent available data showed it was at 39% (School Performance Report 2011-12, n.d.; School Performance Report 2012-13, n.d.; School Performance Report 2013-14, n.d.; School Performance Report 2014-15, n.d.; School Performance Report 2015-16, n.d.; School Performance Report 2016-17, n.d.). Together, the low graduation rate and the high suspension rate indicated a problem with noncognitive skills at the urban high school in New Jersey.

Table A4

Suspension Rate at an Urban High School in New Jersey

	11-12	12-13	13-14	14-15	15-16	16-17
Suspension Rate	26%	39%	41%	40%	23%	39%

Students that took the geometry PARCC exam during the 2016-17 school year were invited to participate in my study so that a single achievement score could be used to measure mathematics achievement from one exam. The geometry PARCC exam was selected because most students take this course during their 9th, 10th, or 11th-grade year, while some students take algebra 1 in 8th grade and some students take algebra 2 in 12th grade. This approached increased the chances of the selected students having an available geometry PARCC score from the 2016-17 school year and still being enrolled at the local site during the 2017-18 school year. Using students that were still enrolled made it possible to invite students to participate in my study and still be able to administer the preestablished noncognitive surveys to them. Three self-report surveys were used to quantify the noncognitive skills mindset, grit, and self-control, with each measure producing a separate score for each student in the sample.

The Results

Survey data was collected for the noncognitive skills mindset, grit, and self-control, through the use of online surveys. The final sample size for the analysis was 97 students. According to Cohen (1992), a sample of 97 in a study of this type was estimated to have a medium effect size. Putting the sample size and effect size into G*Power software for a two-tailed test, the resulting power was 87% (Citea, 2014). First, the descriptive statistics were analyzed. There were 388 total students that had an eligible 2016-17 geometry PARCC score. The mean mathematics achievement score from the sample, 727, was slightly higher than the school's mean of 719. The mean mindset score was 4.4 out of 6, the mean grit score was 3.4 out of 5, and the mean self-control was 2.3 out of 5.

Table A5

Descriptive Statistics for Noncognitive Skills and Mathematics Achievement

	Mean	Standard Deviation	N
Mindset	4.3557	.87653	97
Grit	3.3724	.49967	97
Self-Control	2.3054	.86846	97
Math Achievement	727.0309	25.96931	97

Looking at the scatterplots for each noncognitive skill and mathematics achievement, the data appeared to be linear with no obvious curves or extreme outliers (See Figures 1, 2, & 3 below). The graphs show a small increase in math achievement as mindset and grit increased. There was a small decrease in math achievement as self-control increased.

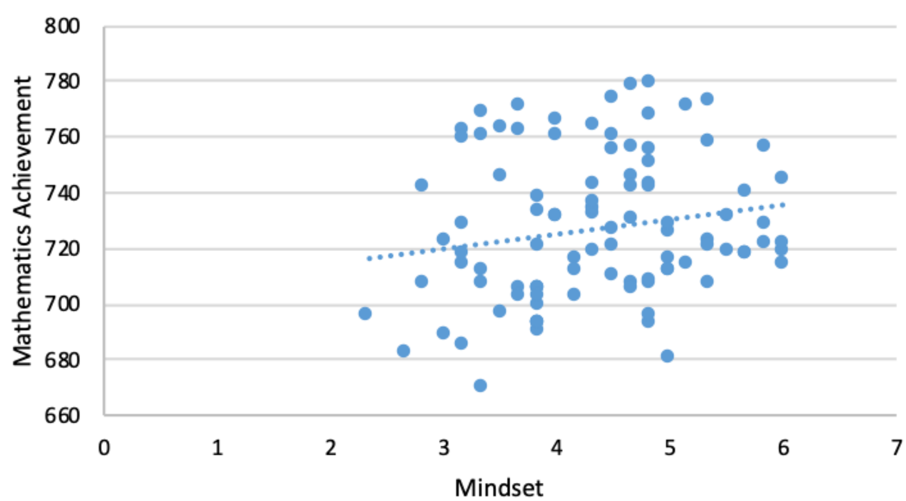

Figure A1. Relationship between mindset and mathematics achievement.

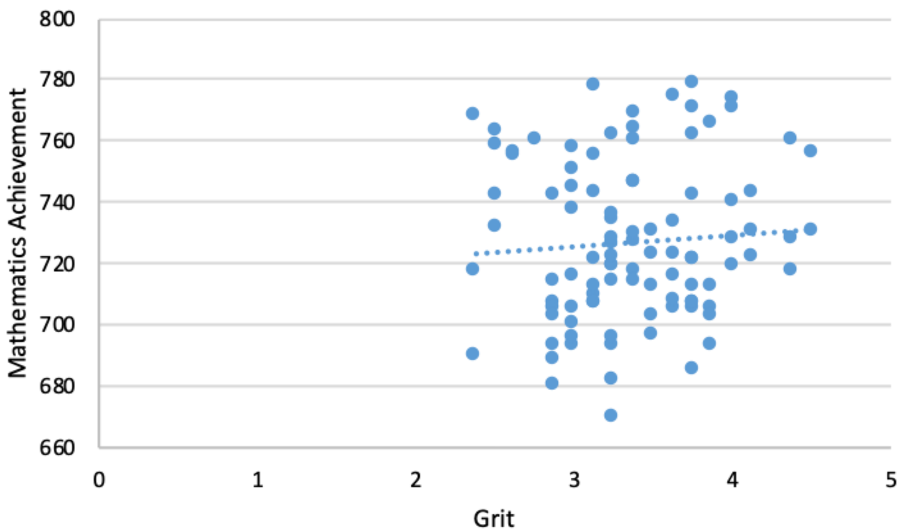

Figure A2. Relationship between grit and mathematics achievement.

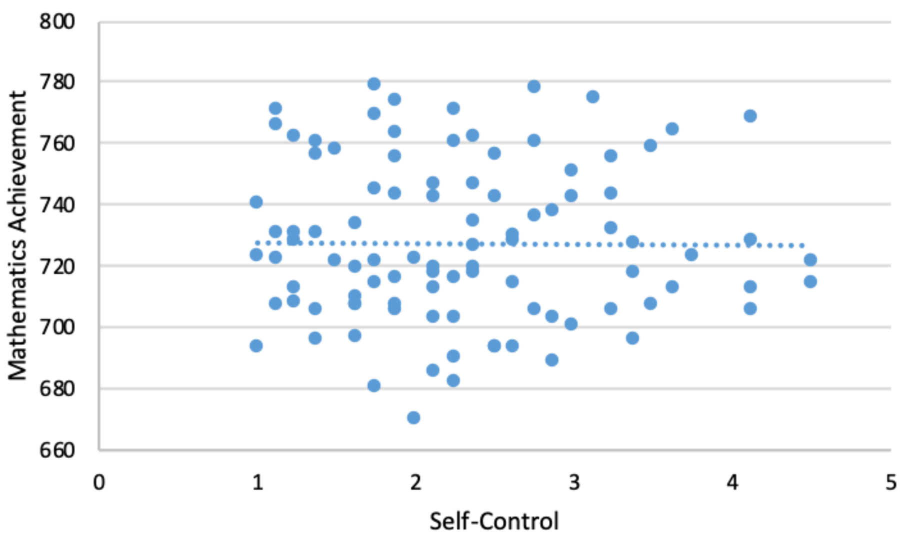

Figure A3. Relationship between self-control and mathematics achievement.

According to LAERD Statistics, a Pearson product-moment correlation value between .1 and .3 shows a small strength of association between the variables (Pearson Product-Moment Correlation, n.d.). The relationship between mindset and mathematics achievement was in the small association range, r = .1720. However, the relationship between grit and mathematics achievement was just below the small association range, r = .0700, and the relationship between self-control and mathematics achievement was very close to zero, r = -.0100. A correlation value close to zero indicates no association between the variables. Next, SPSS and Microsoft Excel were used to analyze the data with respect to each research question.

Table A6

Inferential Statistics for Noncognitive Skills and Mathematics Achievement

	R	R^2	F-Statistic	P-Value
Mindset	.1720	.0296	2.9026	.0917
Grit	.0700	.0049	.4725	.4935
Self-Control	-.0100	.0001	.0091	.9243

The three noncognitive skills did not have statistically significant relationships with mathematics achievement. The findings suggested that there was only a small association between academic mindset and mathematics achievement. Based on those results and The National Council of Teacher of Mathematics (NCTM) positions, I will be recommending a more comprehensive and evaluative intervention approach to address low mathematics achievement at the urban high school in New Jersey. A specific focus on noncognitive skills will not benefit all students, so various interventions should be used to target specific student needs through the use of formative assessments (Garcia, McCluskey, & Taylor, 2015; Killion & Roy, 2009; Marzano, Heflebower, Hoegh, Warrick, & Grift, 2016; National Council of Teachers of Mathematics, 2011).

Additional Problems

Results from my study showed that noncognitive skills such as mindset, grit, and self-control have little to no association with mathematics achievement at the urban high school in New Jersey. From these results, it was clear that any new interventions need to be evaluated to ensure that they are having a positive impact on students' performance. Recently, the urban high school in New Jersey has gone through budget cuts that resulted in the loss of staff, including instructional supervisors. According to the NCTM, support is necessary to monitor and improve instructional practices (National Council of Teachers of Mathematics, 2010). In response to the reduction of staff, professional learning communities (PLC) run by teacher leaders were implemented to help guide the professional development process.

Assigned teacher leaders for each department are now responsible for planning meetings, implementing PLC activities, and monitoring the professional development for all teachers in their department. While some teachers at the high school are improving under the new collaborative leadership model, it is possible that others are unwilling to adapt. In a PLC, teachers should collect and use data to identify weaknesses so that improvements and interventions can take place (Garcia et al., 2015; Killion & Roy, 2009). Restructuring the leadership responsibilities and starting the PLC process are two big endeavors to take on simultaneously. At the urban high school in New Jersey, it is unclear how well these collaborative teams are functioning because there is a lack of evaluation in the process. When implementing big transitions it is crucial to invest support where it is needed and track progress to sustain growth (Garcia et al., 2015).

In the book *Collaborative Teams that Transform Schools*, it described the need for second-order change when shifting from traditional teaching methods to more collaborative methods (Marzano et al., 2016). Second-order change requires support from all stakeholders and highly skilled leadership to guide the process (Marzano et al., 2016). At the urban high school in New Jersey, the administrators are understaffed and sharing leadership responsibilities with teachers. A shared leadership model will only work if those teacher leaders are properly trained and highly motivated to transform the school. There are currently two new leadership styles being implemented simultaneously, transformative and shared. While both styles are attainable and can coexist, it will require a change in the current policy.

The Solution

The use of collaboration through PLCs is a widely used and effective method of transforming schools (Marzano et al., 2016). This is a difficult transition for any school district to accomplish and the recent financial challenges only make it more perplexing. It is important to have an ambitious vision, but it is also equally important to make sure policy supports these efforts so they do not fade over time (Quin, Deris, Bischoff, & Johnson, 2015). My recommendations to improve mathematics achievement at the urban high school in New Jersey is to have a more comprehensive and evaluative intervention approach that includes redefining the role of teacher leaders, adding mathematics specialists, and improving the use of formative assessments (National Council of Teachers of Mathematics, 2010; National Council of Teachers of Mathematics, 2011).

The first change in policy should be to clearly define the role of teacher leaders. The shared responsibilities with administrators can be unclear and underappreciated because it is currently an ambiguous title. Time could be built into the teacher leaders schedules as part of their daily routine or they could be better compensated for the extra responsibilities they have taken on. Another option is to give teacher leaders a smaller class load so they have more time during the day to prepare and complete their additional duties. Multiple times a school year teacher leaders are expected to schedule benchmarks, organize data, disseminate data, plan PLC activities, and oversee PLC meetings. These tasks are time-consuming and are typically overseen by someone in a formal leadership role. If the district is not going to replace instructional supervisors to carry out these tasks, they should better define the role of teacher leaders.

Another change in policy the district should make is adding more mathematics specialists to support instruction. These highly qualified individuals should have experience teaching mathematics, a high level of content knowledge, and an advanced education degree with a focus on pedagogy (National Council of Teachers of Mathematics, 2010). Currently in our district, there are only 2 mathematics coaches compared to 9 ELA coaches and 2 ELA coordinators. While reading skills are very important in education, it is also important to start developing mathematics skills as early as possible. By better balancing the subject focus of our coaches and coordinators, we would have improved mathematics instruction that would help prevent mathematics achievement gaps (Galindo & Sonnenschein, 2015). These mathematics specialists could also take on some of the many leadership responsibilities that are currently being shared by administrators and teacher leaders.

Better defining the role of teacher leaders and hiring more mathematics specialists will lead to more productive PLCs. Teachers have limited time to research best practices and plan innovative pedagogy during the school day. Collaboration is an important part of the process to learn new skills from peers, but every school and grade level is unique with its own set of challenges. With the right type of support, various intervention strategies could be implemented based on the specific needs of the students. Then an evaluation of the changes can be made to direct decision making about the new changes. With better teacher support the PLC process will improve, which will result in better instruction and an increase in mathematics achievement (Chauraya & Brodie, 2017; Garcia et al., 2015; Killion & Roy, 2009).

The final change in policy that the district should implement is a more evaluative intervention approach that includes improving the use of formative assessments. Currently at the urban high school in New Jersey, many are using quarterly benchmarks on edConnect as their only common formative assessment. Over time, this should be expanded to include more frequent common assessments that help guide instructional decisions (Marzano et al., 2016). More time is needed for teachers to collaborate and generate these types of assessments. It also takes a lot of time to go over the results and have productive conversations about how future instruction should be altered. Teachers would be much more likely to adapt in an environment that offered them various levels of support and more designated PLC time built into their schedule (Eaker & Keating, 2012).

After an extensive review of the literature two intervention themes emerged, school-level and classroom-level. It is the responsibility of school leadership to implement, monitor, and evaluate the school-level interventions that apply to everyone. It is also just as important for leadership to prioritize time for PLCs to meet and allow creativity so they can produce the necessary classroom-level interventions for their students. Also, the leadership teams should be constantly evaluating and supporting both levels of intervention strategies to make sure continual progress is being made. The NCTM does not recommend any specific intervention strategies because it is an evolving process that needs frequent adjustments (National Council of Teachers of Mathematics, 2011). Still, there are many effective intervention strategies available in the research that could be implemented in our schools to start improving instruction and achievement.

Goals and Implications

The goal of this white paper was to be part of the solution for increasing mathematics achievement through a more comprehensive and evaluative intervention approach. I have suggested some current options we have, but it will take the actions of many to achieve this vision. The increasing achievement goal will take a long time to come to fruition, but it is data that can be observed each year on the state assessment. I will continue to work with the key stakeholders to suggest and support any changes to policy that will influence future increased mathematics achievement as well as an associated evaluation strategy for each. The key stakeholders that would oversee these changes are the district leadership team and the school leadership team.

Low mathematics achievement is a problem for many school districts in our country. This white paper has the potential to influence policy change that will lead to an increase in mathematics achievement at the urban high school in New Jersey. This would definitely be positive social change to the school and the entire community. Higher achievement scores would help the image of the school and the self-esteem of all community members. The urban high school in New Jersey has had low achievement scores for a long time and the cyclical process makes it more difficult for the next generation to break that cycle. Through the use of various school-level and classroom-level interventions, mathematics instruction can be improved (National Council of Teachers of Mathematics, 2011). Many urban schools score much lower than the state average and changing this trend would be a major accomplishment.

It is also possible that with higher mathematics achievement scores more students would pursue STEM fields in college and in the workforce. Addressing the lack of STEM graduates ready for the workforce at the local level is the first step in reversing the national trend (Beilock & Maloney, 2015). Improved mathematics achievement at the urban high school in New Jersey will help us expand the current STEM programs from enrichment to a regular part of the curriculum. Enhancing STEM programs is a necessary progression due to the New Jersey Next Generation Science Standards that inspire to have additional training for teachers to offer more STEM related courses (New Jersey Next Generation Science Standards, n.d.). The state and national effort to increase the number of STEM graduates can only be successful if local school districts start to change policy to improve mathematics instruction at the local level.

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Appendix B: Email Inquiry to use Survey Instruments

Joseph Costello <joseph.costello@waldenu.edu> Thu, Nov 12, 2015 at 3:59 PM
To: contact@perts.net

Hello,

My name is Joseph Costello and I am a Doctoral student at Walden University. I am currently writing a proposal for my project study and wanted to request written permission to use your survey. My research project is titled "The Relationship of Non-Cognitive Skills to High School Mathematics Achievement." The analysis will include quantifying the way students perceive their own intelligence, so I would like to use the "Implicit Theories of Intelligence Scale for Children – Self Form." I will not change the survey and I will properly cite it in my work. Hope you can help me with this request.

Thank You,

Joseph Costello

Walden University

Doctoral Student

Rachel Herter <rachel@perts.net> Thu, Nov 12, 2015 at 7:19 PM
To: Joseph Costello <joseph.costello@waldenu.edu>

Hi Joseph,

Thanks for reaching out! You may absolutely use the scale - our lab actually didn't develop the TOI scale. It was developed by Carol Dweck.

You can cite the Blackwell et al. (2007) paper or her book - "Self-theories: Their role in motivation, personality, and development."

Best of luck with your research!

Best,
Rachel
[Quoted text hidden]
--
Rachel Marie Herter
PERTS Lab, Dept. of Psychology
Stanford University
rachel@perts.net

413.687.5008
perts.net

Joseph Costello <joseph.costello@waldenu.edu> Thu, Nov 12, 2015 at 3:50 PM
To: duckworthlab@gmail.com

Hello,

My name is Joseph Costello and I am a Doctoral student at Walden University. I am currently writing a proposal for my project study and wanted to request written permission to use your surveys. My research project is titled "The Relationship of Non-Cognitive Skills to High School Mathematics Achievement." The analysis will include grit and self-control scores, so I would like to use the “8-Item Grit Scale” and the “Domain-Specific Impulsivity Scale for Children.” I will not change the surveys and I will properly cite them in my work. Hope you can help me with this request.

Thank You,

Joseph Costello

Walden University

Doctoral Student

Duckworth Lab <duckworthlab@gmail.com> Thu, Nov 12, 2015 at 5:20 PM
To: Joseph Costello <joseph.costello@waldenu.edu>

Hi Joseph,

Thank you for your email regarding the use of Grit Scale and the “Domain-Specific Impulsivity Scale for Children.”. These scales are copyrighted by Dr. Duckworth and co-authors. As detailed here, https://sites.sas.upenn.edu/duckworth/pages/research, the scale can only be used for educational or research purposes. The scales cannot be used for any commercial purpose, nor can they be reproduced in any publication. You are free to use it in your research as long as you follow these guidelines.

Best,

Duckworth Lab