THE ROLE OF ACADEMIC MINDSETS UPON THE MATHEMATICS ACHIEVEMENT OF EIGHTH-GRADE FEMALE STUDENTS

by

STEPHANIE LAVERNE LEGGETT

A Dissertation Submitted to the Faculty in the Curriculum and Instruction Program of Tift College of Education at Mercer University in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

Macon, GA

2016
THE ROLE OF ACADEMIC MINDSETS UPON THE MATHEMATICS ACHIEVEMENT OF EIGHTH-GRADE FEMALE STUDENTS

by

STEPHANIE LAVERNE LEGGETT

Approved:

________________________________________________________________________________________
Clemmie B. Whatley, Ph.D., SPHR
Dissertation Committee Chair

________________________________________________________________________________________
Cynthia Anderson, Ed.D.
Dissertation Committee Member

________________________________________________________________________________________
Jeffrey Hall, Ed.D.
Dissertation Committee Member

________________________________________________________________________________________
Sharon Murphy Augustine, Ph.D.
Chair, Tift College of Education, Macon

________________________________________________________________________________________
Jane West, Ed.D.
Director of Doctoral Studies, Tift College of Education

________________________________________________________________________________________
Keith E. Howard, Ph.D.
Interim Dean of Graduate Studies
DEDICATION

To Sierra, my beautiful daughter, who has cheered me on and been a constant supporter. You are so important to me and I will never be able to repay your sacrifice of my time spent on this dissertation. You have sacrificed much and been right beside me during this journey with much love and support. I am so proud of you and the wonderful young lady you are, my greatest blessing!

To my parents, you both continue to support me in all my endeavors. Your love and support are amazing and greatly appreciated. Life has taken me along many paths, and you have been there with outstanding support on every path. Your encouragement helps me to rise and conquer challenges as I strive to be successful. Mom, you have always taught me that I can do anything. You were right! Thanks for being my biggest cheerleader and supporter. I am so honored to be your daughter and have parents who love me unconditionally.

To Mom, Dad, Sierra, Michelle, Nickey, Kourtnei and Armani, the Hall family group, our love and encouragement of each other has brought a smile to my face and the “I can attitude” to my mind when the task seemed too great . . . . what a wonderful family I have.

To Donald Leggett, my late husband, who started this journey with me and is now in heaven with the great cloud of witnesses cheering for me. You stated from the beginning that I am “something serious” and needed to realize the God given power
within me to do ALL things through Christ. Honey, you were right. I reached the goal and will forever love you!
ACKNOWLEDGMENTS

To Dr. Clemmie B. Whatley, the chair of my committee, your guidance, support, and kindness will forever be appreciated and remembered. Thank you for your willingness to be my chair, share your expertise, and accept questions on a moment’s notice, whether through email or phone call. Your gentleness and kindness have propelled me to greatness from our first meeting. Thank you for helping me make this work possible.

To Dr. Cynthia Anderson and Dr. Jeffrey Hall, my committee members, thank you for your direction, leadership and encouragement throughout this endeavor. Your wisdom and expertise have certainly helped me reach this goal. Thank you for being the committee to guide me toward completion.

To Dr. Barbara Rascoe, my former chair and professor, who has always encouraged me and voiced the greatness you saw in me. I am thankful for your love and understanding through the many life events that I encountered during this journey. Your constant reminder of my potential caused me to focus on the goal despite what has occurred in my past. Thank you for being you with your unique way of motivation.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xi</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>xii</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>5</td>
</tr>
<tr>
<td>Purpose of the Study</td>
<td>6</td>
</tr>
<tr>
<td>Theoretical Framework</td>
<td>8</td>
</tr>
<tr>
<td>Research Questions and Hypotheses</td>
<td>10</td>
</tr>
<tr>
<td>Delimitations</td>
<td>11</td>
</tr>
<tr>
<td>Significance of the Study</td>
<td>11</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>12</td>
</tr>
<tr>
<td>Summary</td>
<td>13</td>
</tr>
<tr>
<td>2. REVIEW OF RELATED LITERATURE</td>
<td>14</td>
</tr>
<tr>
<td>Gender Stereotypes and Math Achievement</td>
<td>14</td>
</tr>
<tr>
<td>Middle School Students’ Attitudes toward Math</td>
<td>18</td>
</tr>
<tr>
<td>Trends in International Mathematics and Science Study</td>
<td>21</td>
</tr>
<tr>
<td>Content Domains of the TIMSS</td>
<td>22</td>
</tr>
<tr>
<td>Number</td>
<td>23</td>
</tr>
<tr>
<td>Algebra</td>
<td>23</td>
</tr>
<tr>
<td>Geometry</td>
<td>24</td>
</tr>
<tr>
<td>Data and Chance</td>
<td>24</td>
</tr>
<tr>
<td>Motivational Constructs of the TIMSS</td>
<td>25</td>
</tr>
<tr>
<td>Students Like Learning Mathematics</td>
<td>26</td>
</tr>
<tr>
<td>Students Value Mathematics</td>
<td>27</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>Students Confident in Mathematics</td>
<td>28</td>
</tr>
<tr>
<td>Criticism of TIMSS</td>
<td>29</td>
</tr>
<tr>
<td>U.S. Eighth-Grade Student Math Performance on TIMSS 2011</td>
<td>31</td>
</tr>
<tr>
<td>Academic Mindsets</td>
<td>32</td>
</tr>
<tr>
<td>Sense of Belonging</td>
<td>34</td>
</tr>
<tr>
<td>Belief in Success</td>
<td>35</td>
</tr>
<tr>
<td>Belief in Effort</td>
<td>35</td>
</tr>
<tr>
<td>Belief in Task Value</td>
<td>36</td>
</tr>
<tr>
<td>Promoting Academic Mindsets</td>
<td>37</td>
</tr>
<tr>
<td>Fixed and Growth Mindsets</td>
<td>38</td>
</tr>
<tr>
<td>Mindsets and Resilience</td>
<td>40</td>
</tr>
<tr>
<td>Impact of Mindsets</td>
<td>43</td>
</tr>
<tr>
<td>Gender Differences and Mindsets</td>
<td>44</td>
</tr>
<tr>
<td>Ability Grouping and Mindsets</td>
<td>44</td>
</tr>
<tr>
<td>Mindsets and Math Learning</td>
<td>47</td>
</tr>
<tr>
<td>Mindsets and Math Achievement</td>
<td>50</td>
</tr>
<tr>
<td>Essentials of Mathematics, Grades 7-12</td>
<td>51</td>
</tr>
<tr>
<td>Educators’ Response/Teaching Mindsets</td>
<td>53</td>
</tr>
<tr>
<td>Summary</td>
<td>56</td>
</tr>
</tbody>
</table>

3. RESEARCH DESIGN AND METHODOLOGY ........................................... 57

| Research Design | 58 |
| Study Setting | 59 |
| Participants | 60 |
| Data Collection | 60 |
| Data Analysis | 61 |
| Validity and Reliability of the TIMSS | 65 |
| Limitations, Assumptions, and Design Controls | 67 |
| Ethical Considerations | 67 |
| Summary | 68 |

4. RESULTS ................................................................. 69

<p>| Purpose of the Study Reiterated | 69 |
| Research Questions and Related Null Hypotheses | 70 |
| Descriptive Data | 71 |
| Findings | 75 |
| Research Question 1 | 75 |
| Research Question 2 | 77 |</p>
<table>
<thead>
<tr>
<th>Value Mindset Scale for Females and TIMSS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Subscales Relationship ......</td>
<td>78</td>
</tr>
<tr>
<td>Algebra .......................................</td>
<td>79</td>
</tr>
<tr>
<td>Data and Chance ................................</td>
<td>79</td>
</tr>
<tr>
<td>Number ........................................</td>
<td>80</td>
</tr>
<tr>
<td>Geometry ......................................</td>
<td>80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Like Mindset Scale for Females and TIMSS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Subscales Relationship ......</td>
<td>81</td>
</tr>
<tr>
<td>Algebra .......................................</td>
<td>81</td>
</tr>
<tr>
<td>Data and Chance ................................</td>
<td>82</td>
</tr>
<tr>
<td>Number ........................................</td>
<td>82</td>
</tr>
<tr>
<td>Geometry ......................................</td>
<td>83</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Confident Mindset Scale for Females and TIMSS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Subscales Relationship ............</td>
<td>83</td>
</tr>
<tr>
<td>Algebra .......................................</td>
<td>83</td>
</tr>
<tr>
<td>Data and Chance .................................</td>
<td>84</td>
</tr>
<tr>
<td>Number ........................................</td>
<td>85</td>
</tr>
<tr>
<td>Geometry ......................................</td>
<td>85</td>
</tr>
</tbody>
</table>

Mindset Effect Size ................................| 86   |
Summary ........................................... | 87   |

5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS 89

Research Questions and Hypotheses Reiterated .................. 90
Summary of Study .......................................... 90
Discussion of Findings ...................................... 91
Analysis and Discussion of the Research Findings ............. 91
   Research Question 1 ..................................... 91
   Research Question 2 ..................................... 92
Conclusions .................................................. 94
Implications ............................................... 95
Recommendations for Future Research ......................... 96
Final Thoughts ............................................ 98

REFERENCES ............................................... 100

APPENDICES ............................................... 109

A PERMISSION TO INCLUDE TIMSS MATERIALS ............... 110
TABLE OF CONTENTS (Continued)

APPENDICES

<table>
<thead>
<tr>
<th></th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>TIMSS SURVEY</td>
</tr>
<tr>
<td>C</td>
<td>INTERNATIONAL TRENDS IN MATHEMATICS ACHIEVEMENT BY GENDER: 8TH GRADE</td>
</tr>
<tr>
<td>Table</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>U.S. Eighth-Grade Student Math Performance for TIMSS 1995-2011</td>
</tr>
<tr>
<td>2</td>
<td>Research Variables</td>
</tr>
<tr>
<td>3</td>
<td>Alignment between Dweck’s Fixed Mindset Traits and TIMSS Eighth-Grade Mathematics Survey</td>
</tr>
<tr>
<td>4</td>
<td>Alignment between Dweck’s Growth Mindset Traits and TIMSS Eighth-Grade Mathematics Survey</td>
</tr>
<tr>
<td>5</td>
<td>Descriptive Statistics for TIMSS 2011 Overall Score, Subscales, and Mindset Scales of Eighth-Grade Female Participants</td>
</tr>
<tr>
<td>6</td>
<td>Descriptive Statistics for TIMSS 2011 Overall Score, Subscales, and Mindset Scales of Eighth-Grade Male Participants</td>
</tr>
<tr>
<td>7</td>
<td>Pearson’s $r$ for the Relationship between Female Students’ Mindset Scales, Overall TIMSS Math Score, and Mindset Effect Size</td>
</tr>
<tr>
<td>8</td>
<td>Pearson’s $r$ for Each TIMSS Subscale and Mindset: Females</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Female Math Achievement on the 2011 TIMSS</td>
<td>73</td>
</tr>
<tr>
<td>2</td>
<td>Female Mindset Scores on the 2011 TIMSS</td>
<td>74</td>
</tr>
<tr>
<td>3</td>
<td>Mindset Effect Size for Females on TIMSS 2011</td>
<td>86</td>
</tr>
</tbody>
</table>
ABSTRACT

STEPHANIE LAVERNE LEGGETT
THE ROLE OF ACADEMIC MINDSETS UPON THE MATHEMATICS ACHIEVEMENT OF EIGHTH-GRADE FEMALE STUDENTS
Under the direction of CLEMMIE WHATLEY, Ph.D.

The purpose of this study was to determine if there was a correlation among the academic mindsets and the achievement of eighth-grade female students. The study utilized archival data from the Trends in International Mathematics and Science Study (TIMSS) of 2011. The sample population included 5,164 eighth-grade female students in the United States.

Quantitative methods served to analyze the archival data to determine if there were statistically significant correlations between the variables under consideration for each of the research questions. The archival data included the participants’ mathematics scores, content domain scores, and survey results from the TIMSS questionnaires. Using the Statistical Package for Social Sciences (SPSS) software, Pearson correlation coefficients were calculated for each set of variables. Multiple analyses were calculated for each research question in order to examine differences based on the role of academic mindsets. The researcher determined that the effect sizes of academic mindsets were small and medium to medium-large when considering the mathematics academic achievement of eighth-grade females in the sample population. Pearson’s $r$ relationship between female students’ mindset and overall TIMSS math scores demonstrated an effect
size for Value ($r^2 = .015$) and Like ($r^2 = .037$); whereas the mindset effect size for
Confidence ($r^2 = .152$) was found to be medium to medium large for Confidence. This
finding was true also in relation to content domains. The effect sizes for Value were
small in Algebra ($r^2 = .015$), Data and Chance ($r^2 = .006$), Number ($r^2 = .008$), and Geometry
($r^2 = .018$). The effect sizes for Like were small in Algebra ($r^2 = .05$), Data and Chance
($r^2 = .02$), Number ($r^2 = .04$), and Geometry ($r^2 = .03$). However, the effect sizes for
Confidence were medium to medium large in Algebra ($r^2 = .16$), Data and Chance
($r^2 = .10$), Number ($r^2 = .14$), and Geometry ($r^2 = .13$).
CHAPTER 1
INTRODUCTION TO THE STUDY

Mathematics is foundational for study along with various school subjects, including sciences. Mathematical problem solving builds reasoning and logical skills that are applicable in daily situations in everyday life. The world is becoming more “quantified”, requiring students to be well grounded in mathematical and technological thinking. Effective citizens need mathematics to understand daily news and world events that outline changes of increases and decreases, often described with statistics. Students considering future careers often find mathematics is important to some degree in most occupations (Mullis et al., 2012).

This study examined barriers that impact mathematics academic achievement of eighth-grade females in the United States who participated in the Trends in International Mathematics and Science Study (TIMSS) of 2011. This investigation addressed issues relating to middle school mathematics, academic mindsets, mathematics academic achievement of females, and the females’ desire to enter courses and careers in science, technology, engineering, and mathematics (STEM). The vital role of academic mindsets and their relationship on academic achievement in mathematics were of focus.

As a result, this study provides effective practices and information for stakeholders of education including teachers, parents, and legislators. This body of research has the potential to increase education stakeholders awareness of the impact that
academic mindsets have on mathematics achievement by examining the mathematics scores and survey results of eighth-grade females who participated in the TIMSS 2011. The TIMSS involves the assessment of fourth- and eighth-grade students, yielding a wealth of information useful to the modification and enhancement of mathematics education. TIMSS has an ongoing goal to help the educational leaders of countries make data-informed decisions to improve teaching and learning in mathematics (Mullis, Martin, Foy, & Arora, 2012).

Beede et al. (2011) explained that the acronym STEM refers to science, technology, engineering, and mathematics. STEM careers include “professional and technical support occupations in the fields of computer science and mathematics, engineering, and life and physical sciences” (Beede et al., 2011, p. 2). However, “there is less agreement about whether to include other positions such as educators, managers, technicians, healthcare professionals, and social scientists” (p. 2). Fouad et al. (2010) reported new developments and the focus on STEM curricula and careers, highlighting the need to enhance the participation of eighth-grade female students. Studies have been conducted nationwide regarding middle school mathematics and the participation of females in STEM careers (Wang, Eccles, & Kenny, 2013). Dweck (2008) shared evidence that students’ mindsets play a key role in their math and science achievement. Dweck further explained that students whose mindset is fixed believe that intelligence along with math and science ability is a fixed trait. However, more of an advantage is found when students believe that their abilities can be developed, referred to by Dweck as
a *growth mindset*. Dweck’s (2008) research emphasized the important role of mindsets in the underachievement of women and minorities in the areas of math and science.

Dweck (2008) further established that teachers and students possess different beliefs about intellectual abilities. Some support the notion of fixed abilities, which purports that people have different levels of ability and nothing can change that ability. Conversely, others believe in the cultivation of intellectual abilities through instruction and application. This latter belief does not deny that people may differ in skill levels, but the belief supports that everyone can improve their underlying ability. Research indicates students tend to have a fixed mindset and view of their math skills more than in any other intellectual skills (Dweck, 1999).

Mindsets predicting math and science achievement have been researched at various age levels. For example, Blackwell, Trzesniewski, and Dweck (2007) assessed fixed and growth mindsets of 373 New York seventh-grade students with equal math achievement prior to seventh grade. The investigators found that by the end of the fall term, the math grades of the fixed and growth mindsets students had dispersed and continued to disperse over the next two years. Students believing in effort focused on learning and remained resilient despite setbacks. However, those with a fixed mindset worried about their mistakes and looking smart and purported that making an effort to learn was an indication that their intelligence was deficient. In addition, these students believed that setbacks reflected their limited intelligence and led them to feel discouraged (Blackwell et al., 2007).
In another study investigating the effect of mindset, Grant and Dweck (2003) examined college students’ achievement in an organic chemistry course. They found that the growth orientation versus a fixed ability orientation predicted higher final grades and attributed the grade advantage to use of deeper learning strategies by students with a growth mindset. Furthermore, the fixed mindset predicted students’ failure to recover from a poor grade, whereas students with a growth mindset predicted successful recovery (Grant & Dweck, 2003). However, in many studies, well-prepared students did not encounter difficulties and performed well despite having a fixed mindset. Dweck, Walton, and Cohen (2011) explained that it is necessary for students to think of themselves and school in certain ways in order for them to want to learn and learn successfully.

Boaler (2013) outlined a study conducted by Good, Aronson, and Inzlich (2003) that provided a growth mindset intervention for seventh-grade students, wherein mentors met with students in person for 90 minutes at the beginning of the semester and again for 90 minutes at the beginning of the next semester. Additional communication with mentors and students occurred through email. Although there was no statistical significance associated with the gain from this study, the growth mindset intervention led to a 4.5-point gain in students’ test scores in mathematics. In addition, Boaler (2013) noted a significant gender difference in mathematics in the control group—a gap largely eliminated in the growth mindset group. In the control group, which did not receive intervention, males outperformed females. Conversely, math scores increased for both males and female students due to the experimental manipulations. Interestingly, the
manipulations suppressed the stereotype threat and appeared particularly beneficial for the female students. The gender gap in math performance disappeared due to the females learning about the expandability of intelligence. The pronunciation of math performance was greater for the female students due to improved performance through helpful learning attitudes, rather than by additional skills, drilling, or intense study of test content.

Female performance in mathematics and their academic mindsets are important areas of concern and continued focus. Gender gaps must be minimized, if not eliminated in teaching, learning, and academic achievement for all students. As society increases the focus on women in STEM careers, research results and effective strategies are necessary to empower female attitudes and beliefs regarding mathematics and the ability to be successful.

Statement of the Problem

To be successful educationally and financially, mathematical knowledge is crucial in contemporary society (Siegler et al., 2012). Mathematical knowledge has increased in recent decades, probably due to the growing number of well-paying jobs that require mathematical proficiency. However, many students lack basic competency in mathematics to perform typical jobs. Despite 30 years of nationwide standardized testing and intervention, the mathematics scores of secondary students have not significantly increased. The U.S. Department of Education State Educational Technology Directors Association report of 2010 highlighted the number of adolescents in the U.S. trailing behind those in industrialized countries in their academic performance, especially in
mathematics (Cheung & Slavin, 2011). Siegler et al. (2012) examined predictors of high school students’ knowledge of algebra and mathematics achievement overall and found that the knowledge of fractions and division possessed by elementary school students uniquely predicted the students’ knowledge of algebra and overall mathematics achievement in high school. Recent Program for International Student Assessment (PISA) assessments reveal problems in student performance in mathematics that vary among students and countries (Straus, 2014). The increased emphasis on the need for STEM or science, technology, engineering, arts, and mathematics (STEAM) schools and participants who will choose higher level courses and careers requires a focus to improve mathematics achievement (Mullis et al., 2011). Mathematics achievement is a growing concern at all levels, including middle school eighth-grade female students.

This research has the potential to provide insight and information related to middle school mathematics and female student learning. As middle school mathematics educators continue to create learning experiences to enhance teaching and learning, an increased focus on academic mindsets in mathematics will support teachers with the curriculum, instruction, and assessment of their students and, thereby, positively increase student confidence, achievement, and participation in higher-level courses and mathematic careers (Mullis et al., 2011).

Purpose of the Study

The objective of this study was to contribute to the limited research associated with the correlation of academic mindsets of eighth-grade females and mathematics achievement as outlined by standardized test scores. Included are an examination of
The archival data and the relationship existing among identified academic mindsets and standardized tests scores of mathematics achievement of eighth-grade females.

The purpose of this quantitative research study was to determine if there is a significant statistical correlation of academic mindsets on the mathematics achievement of eighth-grade female students. An investigation was undertaken in regards to students’ beliefs and attitudes in mathematics, including either entity or incremental growth views of ability. Students with entity views have attitudes and beliefs that their intelligence is fixed; conversely, students believing that effort improves their ability and intelligence possess incremental growth views (Dweck & Elliot, 1983).

Dweck and Master (2009) outlined characteristics for both the entity and incremental theories. The entity theory does not encourage a can-do mentality. Patterns displayed are of a helpless orientation as the individual views difficulty as a sign of inadequacy and possesses a pessimistic outlook. This fixed mindset results in a view of success and failure as a reflection of self-worth. Unfortunately, when an individual faces difficulty or experiences high stress, the individual is at risk for anxiety and depression. In the classroom, those with the entity theory (fixed mindset) focus on performance. When encountering a difficult task, these students withhold effort and conceive the idea that they could not have done well if they had tried. They do not value effort and believe that without a high ability level, effort is useless (Dweck & Master, 2009).

The incremental theory encourages a can-do mentality (Dweck & Master, 2009). Patterns displayed are of a mastery orientation as an individual views difficulty as something to overcome and not an indication of personal failure. Therefore, the
individual has an optimistic outlook. This growth mindset results in a view of success and failure as separate from self-worth. When an individual faces difficulty or experiences high stress, the individual views the experience as a learning or growth opportunity. In the classroom, those who believe in the incremental theory (growth mindset) focus on learning. When encountering a difficult task, these students apply effort and achieve mastery or persevere to apply new strategies as necessary. They value effort and believe that with continued effort, they can achieve mastery (Dweck & Master, 2009).

This study examined survey results regarding the academic mindsets and mathematics achievement of eighth-grade females who participated in the TIMSS 2011 study. This research provides information to stakeholders who collaborate in educating eighth-grade females and has the potential to aid the needs of eighth-grade females, identify interventions to change fixed mindsets that are negative regarding mathematics, and increase participation in higher-level mathematics courses and STEM or STEAM careers.

Theoretical Framework

Dweck’s leading research in motivation and her focus on why people succeed served as a theoretical guide for this study. Dweck (2010) emphasized that the importance of equity in education for all students extended beyond equal access to facilities and resources. Although facilities and resources are important, it is increasingly becoming more important to capture the beliefs of administrators, teachers, and students that can affect student achievement. Dweck’s (2006b) research outlined two beliefs
regarding intelligence: fixed or growth mindsets. Students with fixed mindsets believe that some people are intelligent and others are not. Students with fixed mindsets believe that intelligence is a static trait. Conversely, students with a growth mindset believe that intelligence can be developed through effort and instruction. The growth mindset does not outline that everyone is the same but does imply that everyone’s intellectual ability can grow. Dweck (2010) further stated that even “Einstein wasn’t Einstein before he put in years of passionate, relentless effort” (p. 26).

Utilization of implicit theories of intelligence began in the late 1980s (Dweck & Leggett, 1988). Dweck provided a stimulus to empirical research based on the theoretical framework surrounding implicit theories of intelligence. Dweck (1999) outlined the components of implicit theories of intelligence: effort beliefs, goal setting, intrinsic and extrinsic motivation, and self-regulation strategies. Effort beliefs are those beliefs regarding the importance of effort along with strategies and the importance of persisting despite challenge. Goal setting involves students setting goals of achievement and goals that include learning from mistakes and increasing achievement. Intrinsic motivation involves the motivation of students driven by their own beliefs and value of learning and achievement. This motivation leads to possessing self-regulation strategies in which students are active participants in learning who utilize strategies to learn and achieve.

Student beliefs regarding mathematics are varied, consisting of both fixed and growth mindsets of intelligence. In an effort to provide equitable education, Dweck (2010) challenged teachers to teach students that intelligence can be “grown” and that
their intelligence is not fixed, but is capable of being developed. Growth mindsets aid students to focus on effort and provide motivation to overcome challenging work.

Dweck (2015) revisited her research regarding students’ mindsets and the way they view their abilities. She found that students’ mindsets play a key role, and if a way to change students’ mindsets was found, motivation and achievement would increase. Once students learn that they can “grow their brains” (Dweck 2015, p. 1) and increase their ability intellectually, students perform better. Dweck admitted that, as years have passed, she and other researchers have become wiser regarding implementation of the growth mindset. The growth mindset is about more than effort and should not be equated to effort, which is a common misconception. Effort is important, but strategies and feedback are necessary to maximize student benefits from having a growth mindset (Dweck, 2015).

**Research Questions and Hypotheses**

The following research questions guided the investigation in this study and analysis of the archival data to describe the variability among the factors under consideration:

1. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores?

   $H_0$: There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores.
2. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics?

\[ H_0 \]: There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics.

**Delimitations**

Mathematics is a growing concern at all grade levels, locally, nationally, and internationally. However, this study focused only on middle school mathematics and the achievement of eighth-grade females in the United States. Furthermore, this study utilized archival data available from the TIMSS 2011. Whereas this study utilized international data, local school data could provide a different perspective related to factors affecting mathematics achievement and mindsets. Additional factors with the potential to affect middle school mathematics achievement of eighth-grade females outside of Dweck’s concept of mindset were not a part of this study.

**Significance of the Study**

This study contributes to the field of education by providing all education stakeholders—policymakers, administrators, teachers, and interested individuals—with information that focuses on the academic mindsets that are enhancers to middle school mathematics achievement for eighth-grade females. This research can reveal additional information not previously available to teachers and students regarding the relationship and challenges of academic mindsets in mathematics. Having knowledge of academic
mindsets and providing quality learning experiences can positively affect student mathematics achievement.

Additionally, this study focused on mindsets as enhancers to learning of all content. Information regarding academic mindsets can benefit education stakeholders because students learn different content and encounter challenges while learning. Students, teachers, parents, and curriculum designers can benefit from this research in its effort to enhance mathematics teaching and learning.

Definition of Terms

The following definitions serve as a guide for this study:

*Academic achievement* is the academic competency in skill or knowledge according to standards and targets in related content areas. Standardized test results often report academic achievement (Chung, Lin, Huang, & Yang, 2013).

*Academic mindsets* are “the psychosocial attitudes or beliefs one has about oneself in relation to academic work” (Farrington, 2013, p. 3).

*Entity Theory of Intelligence* maintains that that intelligence is a “fixed or uncontrollable trait” (Dweck & Leggett, 1988, p. 262).

*Fixed mindset* is “believing that your qualities are carved in stone” (Dweck, 2006b, p. 6).

*Growth mindset* is “based on the belief that your basic qualities are things you can cultivate through your efforts” (Dweck, 2006b, p. 7).

*Incremental Theory of Intelligence* purports that intelligence is a “malleable, increasable, controllable quality” (Dweck & Leggett, 1988, p. 262).
Trends in International Mathematics and Science Study (TIMSS) is an assessment of four-year studies providing reliable and timely data of the mathematics and science achievement of fourth- and eighth-grade students in the United States as compared to students in other countries (Mullis et al., 2012).

Summary

This chapter introduced the research plan for the study of the relationship between academic mindsets and mathematics achievement of eighth-grade female students. This chapter provided background information, described the problem, and presented a statement of the purpose for this study. Research questions and hypotheses conveyed the intent of the study. Inclusion of the definitions of key terms provides a contextual framework for terminology discussed throughout this research. Chapter 2 presents a review of the literature to provide an analysis of research of middle school mathematics, academic mindsets, and mathematics achievement of eighth-grade female students.
CHAPTER 2

REVIEW OF RELATED LITERATURE

The review of the literature includes an examination of research on middle school mathematics and the possible influence academic mindsets have on improving math achievement. This review comprises the following sections: Gender Stereotypes and Math Achievement, Middle School Students’ Attitudes toward Math, Trends in International Mathematics and Science Survey, U.S. Eighth-Grade Student Math Performance on TIMSS 2011, Academic Mindsets, Mindsets and Resilience, Mindsets and Math Learning, and Mindsets and Math Achievement.

Gender Stereotypes and Math Achievement

The stereotypical notion that males are superior to females in mathematics can have a negative effect, such as impairing female math performance in mathematics or undermining female interest in mathematics fields. Gender differences and stereotypes that contend males possess higher intellectual ability in technical field than females possess have discouraged female interest and pursuit of certain careers. The impact of this stereotype occurs early for females. For instance, Bian, Leslie, and Cimpian (2017) found that girls as young as six years old are less likely than boys are to believe that members of their gender are “really, really smart” (Hennessey, 2017, p. 1). These young girls begin to avoid activities believed to be for “really, really smart” males. These beliefs threaten the cognitive ability and performance of females in mathematics.
Portrayal of gender stereotypes occurs both overtly and covertly through advertisements and products focused on young audiences. Milligan (2016) outlined the controversy involving Barbie, the well-known doll for young girls. The manufacturer, Mattel©, programmed each doll with numerous phrases, one of which was “Math class is tough”. According to Milligan (2016), after receiving criticism for reinforcing gender stereotypes that undermined the confidence of females, the manufacturer eventually removed the phrase from the hundreds of available phrases.

Research details the existence of other gender stereotypes, including the perception that males possess “more natural talent in math” (Gunderson, Ramirez, Levine, & Beilock, 2012, p. 154) and “do not have to put forth as much effort into their math performance” (Milligan, 2016, p. 3). If males do well in math, the assumption is it is due to math ability, whereas female math achievement is due to substantial effort. Milligan (2016) claimed the gap between gender and achievement in math results from interactions among the factors of student relationships with parents, teachers, and the school environment; math anxiety; academic mindset; and achievement goal orientations. Researchers are recognizing the need to utilize academic mindsets to promote math achievement for both females and males (Rattan, Savani, Chugh, & Dweck, 2015).

Some improvements have occurred in mathematics scores since 1995, although students in the United States continue to score lower in mathematics on the Trends in International Mathematics and Science Study (TIMSS) when compared to some countries (National Center for Educational Statistics [NCES], 2009). According to NCES (2009), the eighth-grade average mathematics score for females was 509, which exceeded the
2011 TIMSS scale average of 500. Additionally, students in 11 educational systems scored above the U.S. average mathematics score. Those systems include Korea, Singapore, Chinese Taipei, Hong Kong, and Japan.

Rozek, Hyde, Svoboda, Hulleman, and Harackiewica (2015) stated that numerous interventions have sought to close gender gaps and increase STEM motivation for both females and males. Harackiewick, Rozek, Hulleman, and Hyde (2012) shared the critical need for a foundation in STEM subjects, since U.S. students avoid taking advanced mathematics and science classes in high school. Their investigation sought to determine if intervention was effective equally for girls as for boys. The intervention increased the course enrollment in STEM for high-achieving females and low-achieving males, but failed to help low-achieving females. Harackiewick and colleagues (2012) concluded that females possess lower expectancies for success in STEM domains that males possess. They posited that gender differences may explain the difference in gender achievement and values (Harackiewick et al., 2012).

Not surprisingly, Watt et al. (2012) predicted increased enrollment and success in STEM courses for males rather than females. Males value making money and having successful careers (Eccles, 2007). The prediction of success for males in mathematics and science decreased the expectancy for female success. The value that males and females have for mathematics and science may influence gender differences in STEM enrollment and choices. Interestingly, Eccles (2007) found no differences in gender value of STEM. Gender differences existed in the number of valued domains, which suggests that females place higher value on more domains, both STEM and nonSTEM
related, than males do. This value might lead to high value of STEM being less important for females (Eccles, 2007).

Researchers have outlined sociocultural factors and stereotypes that affect women. Miller, Eagly, and Linn (2015) compared sociocultural factors found across nations that can aid in identifying sociocultural factors that predict gender-science stereotypes. These variables can be found in “mass media, opinion of teachers and peers, participation of family members in science, technology, engineering, and mathematics (STEM) fields; and learning experiences in male-dominated courses” (Miller et al., 2015, p. 631). Eagly and Wood (2012) outlined their colleagues’ social role theory and their observance of women and men in different social roles and how gender stereotypes form and change. The basis for cultural stereotypes results from both direct and indirect interactions that associate typical roles and activities with women and men. Observance of the interactions occurs at early ages. For example, the expectation for females to make sacrifices for their family and work in professions that help people predicts female nonpursuance of STEM careers (Eccles, 2007). Talented females are more likely to experience indecision caused by beliefs in gender stereotypes and desire for accomplishment in mathematics and science. As a result, high-achieving females might avoid enrollment in STEM courses due to cultural stereotypes.

Beilock, Gunderson, Ramirez, and Levine (2010) shared how girls in kindergarten experienced gender stereotypes in mathematics if their teacher was anxious about mathematics. In contrast, Galdi, Cadinu, and Tomasetto (2014) explained how exposure to women scientists and women mathematicians has the potential to weaken gender
stereotypes for young girls. Interestingly, parental influence has resulted in an increase in male and female adolescent enrollment in STEM courses (Harackiewick et al., 2012).

Middle School Students’ Attitudes toward Math

Studies conducted have found that students’ attitudes toward mathematics influence their motivation to learn. For example, in a study conducted by Turner, Meyer, Midgley, and Patrick (2003), middle school students reported mathematics as less valuable and indicated their effort and persistence in mathematics decreased across their first year of middle school, leading the researchers to outline the need to examine processes relating to motivational functioning of middle school students in mathematics.

Academic hopelessness is another attitude that influences motivation and learning for middle grade students. Pekrun (1992) defined academic hopelessness as a negative academic emotion. This emotion occurs when individuals attribute negative outcomes to stable causes and believe that future outcomes will not be better than past ones (Weiner, 1985). Students with academic hopelessness do not feel they have personal control over outcomes they expect (Pekrun, 2006). Unfortunately, this hopelessness may lead to student avoidance of putting forth effort in course-related activities, which results in low performance and learning (Pekrun, Goetz, Frenzel, Barchfield, & Perry, 2011). By concentrating on academic enjoyment and academic hopelessness, Sakiz, Pape, and Hoy (2012) sought to identify ways to foster positive academic emotions and reduce, preempt, or change negative emotions.

Research documents the prediction of student self-perceptions of effort on academic achievement (Wolters, 1999, 2004). Especially important in middle school
mathematics is the relationship between academic effort and academic achievement due to its nature to predict mathematics achievement in high school. This relationship will eventually affect an individual’s chances to enter postsecondary schools (Wang & Goldschmidt, 2003). Thus, students’ self-perceptions of effort influence their performance in mathematical learning.

Students observe carefully the verbal and nonverbal behaviors of teachers, which play a role in student development of self-beliefs and academic behavior (Weinstein & McKown, 1998). Students who felt a greater sense of belonging in their middle school mathematics classrooms were likely to report higher academic enjoyment. A greater sense of belonging will positively affect an individual’s chances to enter postsecondary schools (Wang & Goldschmidt, 2003).

Tseng, Chang, Lou, and Chen (2013) contended that students’ attitudes toward mathematics were similar to their attitudes toward science. In a study conducted by Petocz and colleagues (2006), students mentioned mathematics as a language of science. Students, in terms of learning, viewed mathematics as a difficult subject. Students’ negative attitudes towards mathematics can grow with age, resulting in mathematics typically found as the less popular subject. Negative attitudes towards mathematics increase as students’ learning interest decreases. Walsh (2008) shared that the extent to which a student is anxious about mathematics determines their achievement in mathematics. However, according to Petocz et al. (2006), students acknowledge some advantages provided by mathematics. For example, some students viewed mathematics as “an approach to life and a way of thinking” (Petocz et al., 2006, p. 442).
Wilkins (2014) outlined the decline in academic performance in math and science for middle school students, 11 to 14 years of age. According to Wilkins, disengagement in courses, particularly math and science, have resulted in a decline in achievement. Furthermore, students do not engage in career fields requiring math or science knowledge. The greatest decline in math and science achievement is evident in ethnic minorities and in females, when compared with their male counterparts.

The middle grades decline in math and science achievement can be associated with variables including student adaptation to new and more rigorous expectations, adjustment to increased autonomy, receipt of less individualized interaction due to teacher to student ratio, increase in classes and number of teachers, and the balance of more work. Hulleman and Harackiewicz (2009) concluded that students who fail to have academic success in middle school continue their academic decline throughout their high school years. Consequently, students develop psychological beliefs about their abilities to improve and fail to embrace challenges to enhance growth and their learning potential.

Wilkins (2014) related that middle school reform has sought to increase student achievement in math and science and develop interventions. However, students continue to decline in achievement despite interventions that focus on science, technology, engineering, and math. A solution to the decline is, and continues to be, sought by researchers to develop and provide psychological interventions to affect academic achievement positively.

Middle school students often have attitudes toward mathematics that are negative. The negative attitudes begin at an early age and continue in middle school.
Academic decline begins along with a decrease in motivation, which continues through high school. Negative beliefs and attitudes result in a failure to persevere during challenges. A focus on middle school students’ attitudes toward mathematics can help researchers understand the factors that influence students’ success.

Trends in International Mathematics and Science Study

The Trends in International Mathematics and Science Study (TIMSS) compares the mathematics and science achievement of students in the United States to the performance of students in other countries. The National Center for Education Statistics (NCES), a part of the U.S. Department of Education, manages the study sponsored by the International Association for the Evaluation of Educational Achievement (IEA) in the United States (Mullis, Martin, Foy, & Arora, 2012). The assessments seek to improve teaching and learning in mathematics and science by providing reliable and timely data collected from students in grades 4 and 8 (Mullis et al., 2012). Comprehensive and state-of-the-art assessments of student achievement support the data, which provide information about countries, schools, and classroom learning environments. The study, which occurs every four years, began in 1995. The fifth administration of international assessments was held in 2011 (Mullis et al., 2012).

TIMSS is the series of mathematics and science assessments conducted by the International Association for the Evaluation of Educational Achievement (IEA). The association is an independent international cooperation of national research institutions and government agencies comprised of nearly 70 countries worldwide. Approximately 63 countries participated in TIMSS 2011 (Mullis et al., 2012). Countries and
benchmarking participants decided to participate in the fourth-grade assessment, eighth-grade assessment, or in both. Officials in some countries asserted the assessment was too difficult for fourth- or eighth-grade students, so they elected to assess students at a higher grade. In each country, approximately 4,000 students from 150-200 schools participated in the TIMSS 2011 at each grade assessed. More than 300,000 students participated in the fourth-grade assessment and an additional 300,000 participated in the eighth-grade assessment (Mullis et al., 2012).

Based on a comprehensive framework, the TIMSS 2011 assessment is the result of collaboration of participating countries (Mullis et al., 2012). The mathematics framework is organized around dimensions of content and cognition. The content dimension specifies the domains or subject matter assessed within mathematics, while the cognitive dimension specifies the domains or thinking processes subject to assessment. The content domains for eighth grade are Number, Algebra, Geometry, and Data and Chance. Three cognitive domains describe expected student behaviors as students engage with mathematics content: knowing, applying, and reasoning.

Content Domains of the TIMSS

Content domains consist of several topic areas listed as objectives covered in participating countries (Mullis et al., 2012). The TIMSS 2011 Mathematics Framework offers descriptions and examples of mathematics items and tasks, along with targeted percentages of testing for eighth-grade students. For instance, the eighth-grade content domain delineates the following: (a) Number, 30%; (b) Algebra, 30%; (c) Geometry, 20%; and (d) Data and Chance, 20%.
Each content domain defines the mathematics subject matter covered by the TIMSS 2011 assessment at eighth grade. The content domain topic areas contain objectives outlining the expected student understandings or abilities. The following sections explain the eighth-grade mathematics content domains.

Number. The content domain of number includes student understanding of numbers, various ways of representing numbers, relationships among numbers, and number systems. Students in eighth grade should possess number sense and fluency in computation, understanding of operations meanings and number relation, and ability to solve problems using numbers and operations. The number content domain addresses skills and understanding of whole numbers; fractions and decimals; integers; and ratio, proportion, and percent. Computation emphasizes fractions and decimals, rather than whole numbers.

Using various strategies, eighth-grade students should be able to compute equivalent fractions, decimals, and percentages. Similarly, eighth-grade students should have an extended understanding from whole numbers to integers and the ability to order and perform operations with integers. The TIMSS assessment requires students to solve routine and nonroutine problems set in real-world contexts, as well as mathematical contexts.

Algebra. The algebra content domain includes patterns that require students to recognize and extend patterns, use algebraic symbols to represent mathematical situations, and develop fluency in computing equivalent expressions and solving linear equations. The main topic areas are patterns, algebraic expressions, equations, formulas,
and functions. Students entering eighth grade should have an understanding of linear relationships and the concept of a variable. Students are expected to simplify and use algebraic formulas, solve linear equations and inequalities, solve simultaneous equations involving two variables, and use a range of functions. Students should be able to solve real-world problems using models and explain relationships using algebraic concepts.

Geometry. In the content domain of geometry, eighth-grade students should be able to provide explanations based on geometric relationships and analyze properties and characteristics of two and three-dimensional geometric figures, including lengths of sides and sizes of angles. Students should also be able to apply the Pythagorean Theorem to solve problems. Expectations of students’ abilities include competency in geometric measurement; accurate use of measuring instruments; estimation when appropriate; and the correct selection and use of perimeter, area, and volume formulas.

The geometry content domain also includes an understanding of coordinate representation and use of spatial visualization skills. Three topic areas in geometry are geometric shapes, geometric measurement, and location and movement. Student spatial sense is also important in the study of geometry. The geometry content domain requires students to describe, visualize, draw, and construct various geometric figures, including angles, lines, triangles, quadrilaterals, and other polygons.

Data and Chance. The content domain of data and chance requires students to know how to organize collected data and display data in charts and graphs. Data and chance includes understanding issues related to data misinterpretation. The three major topic areas in data and chance include data organization and representation, data
interpretation, and chance. Students gather and work with simple data, compare various types of displays, and compare data characteristics, such as shape, spread, and central tendency. Students draw conclusions based on displays and identify or make predictions based on data. Furthermore, eighth-grade students’ appreciation of probability should include being able to determine the occurrence of familiar events, likelihood and outcomes.

Motivational Constructs of the TIMSS

Motivational constructs are within the TIMSS, which support positive attitudes towards mathematics and science and the result of higher achievement. Mullis et al. (2012) shared results from successive TIMSS administrations that showed a strong positive relationship within countries between student attitudes toward mathematics and their math achievement, supporting research findings that students with more positive attitudes toward mathematics and science have higher average achievement in mathematics and science. Mullis et al. (2012) further outlined this relationship as bidirectional, with achievement and attitudes mutually influencing each other. Those students who perform well academically in mathematics are also the students more likely to enjoy learning mathematics.

Scales of three motivational constructs are included in the TIMSS 2011 study. These are intrinsic value, commonly referred to as interest, utility value, and individual beliefs about ability. The Students Like Learning Mathematics scale was developed and utilized in the TIMSS studies to measure the liking of learning mathematics and the students’ interest in mathematics (Mullis et al., 2012). The Students Value Mathematics
scale notes the students’ attitudes about the importance of mathematics, as well as the usefulness of the subject, often referred to as the attainment or utility value. The third scale, the Student Confident in Mathematics scale, assesses student self-confidence or self-concept in the ability to learn mathematics. This construct of self-concept encourages an individual to engage with instruction and show attentiveness, persistence and effort.

Students Like Learning Mathematics. According to Mullis et al. (2012), the 4-point Likert scale (Agree a lot; Agree a little; Disagree a little; Disagree a lot) was used for the Students Like Learning Mathematics mindset scale. The scale addressed liking mathematics with five statements:

- I enjoy learning mathematics.
- I wish I did not have to study mathematics.
- Mathematics is boring.
- I learn many interesting things in mathematics.
- I like mathematics (reverse coded) (p. 333).

Results from the TIMSS 2011 Students Like Learning Mathematics survey revealed that, internationally, 48% of the fourth-grade students like learning mathematics, and 16% did not like learning mathematics (Mullis et al., 2012). The remaining 36% reported to somewhat like learning mathematics. Students who liked learning mathematics had higher average mathematics achievement than those who somewhat like learning mathematics. Those students who reported not liking learning mathematics had the lowest average in mathematics achievement (Mullis et al., 2012).
Compared to fourth-grade students, fewer eighth-grade students reported positive attitudes toward learning mathematics (Mullis et al., 2012). The average percentage of fourth-grade students who like learning mathematics was 48%; 36% somewhat like learning mathematics; and 16% of fourth-grade students reported a dislike for learning mathematics. A drop in positive attitudes toward learning mathematics occurred for eighth-grade students. The average percentage of eighth-grade students who like learning mathematics was 26%; 42% somewhat liked learning mathematics; and 31% of eighth-grade students reported a dislike for learning mathematics. The drop in positive attitudes between fourth and eighth grade occurred across all countries tested. Mullis et al. (2012) reported that there exists a direct relationship between the pattern of achievement and the attitudes towards mathematics with positive attitudes toward learning mathematics directly relating to higher average mathematics achievement.

Students Value Mathematics. Only eighth-grade students participated in the administration of the Students Value Mathematics scale. According to Mullis et al. (2012), the 4-point Likert scale (Agree a lot; Agree a little; Disagree a little; Disagree a lot) was used for the Students Value Mathematics mindset scale. The scale addressed six different aspects of valuing mathematics with six statements:

- I think learning mathematics will help me in my daily life.
- I need mathematics to learn other school subjects.
- I need to do well in mathematics to get into the university of my choice.
- I need to do well in mathematics to get the job I want.
• I would like a job that involves using mathematics.
• It is important to do well in mathematics. (p. 335)

Students who either “agreed a lot” with three of the statements or “agreed a little” with the three other statements valued mathematics. Those who “disagreed a little” with three of the statements and “agreed a little” with the other three on average did not value mathematics. Internationally, a high value on mathematics existed for eighth-grade students. Although many did not enjoy learning mathematics, they appreciated the value of mathematics: 46% valued mathematics; 39% somewhat valued mathematics; and only 15% did not value mathematics. Students who said they valued mathematics had higher achievement than students who only valued it somewhat or not at all (Mullis et al., 2012).

Students Confident in Mathematics. The TIMSS 2011 Students Confident in Mathematics scale included seven statements. Students confident in mathematics “agreed a lot” with four of the seven statements and “agreed a little” to the other three. Internationally, 34% of fourth-grade students expressed confidence in their mathematics ability. Mathematics achievement on average was highest for those students who were confident and lowest for students lacking confidence. Some students in the highest performing countries expressed the least confidence (Mullis et al., 2012).

The 4-point Likert scale (Agree a lot; Agree a little; Disagree a little; Disagree a lot) was used for the Students Confident in Mathematics mindset scale (Mullis et al., 2012). The scale addressed students confident in mathematics with nine statements:

• I usually do well in mathematics
• Mathematics is more difficult for me than for many of my classmates
• Mathematics is not one of my strengths
• I learn things quickly in mathematics
• Mathematics makes me confused and nervous
• I am good at working out difficult mathematics
• My teacher thinks I can do well in mathematics with difficult materials
• My teacher tells me I am good at mathematics
• Mathematics is harder for me than any other subject. (Mullis et al., 2012, p. 337)

As compared to the fourth-grade scale, the two additional statements, “Mathematics is harder for me than any other subject”, and “Mathematics makes me confused” addressed the issue of the increasing difficulty of mathematics. Confident students were those “agreeing a lot” to five of the nine statements and “agreeing a little” with the remaining four statements. Internationally, only 14% of eighth-grade students expressed confidence in their mathematics ability. Forty-five percent expressed some confidence, and 41% expressed little confidence. The confidence gap at eighth grade between confident and not confident students was on average 104 points out of a range of 0-1000 (Mullis et al., 2012).

Criticism of TIMSS

The TIMSS study is not without criticism from some researchers. Choi, Lee, and Park (2015) reported that criticism of the TIMSS included allegations that the assessment was typically inapplicable to existing school programs, lacked consideration of cultural context, and seldom utilized. Ferrini-Mundy and Schmidt (2005) called for school
systems, mathematics educators, mathematicians, measurement experts, and educational
statisticians to collaborate to conduct research projects that will be directly applicable to
existing school systems.

In response to this criticism, researchers conducted a secondary analysis of the
TIMSS 2003 study to gain additional perspectives and information beyond average
achievement scores and information regarding percentage correct on items, domains, and
sections of mathematics (Choi et al., 2015). One conclusion reached through the analysis
was the importance of educators knowing exactly what students have learned and
understand. In the analysis, researchers discovered that the ability of Korean students to
find correct answers might be due to reliance on guessing. Therefore, it is critical for
educators to understand that achievement scores can yield to guessing as well as
understanding, which highlights the importance of future studies that may offer unique
perspectives on the TIMSS other than average achievement scores and percentage
correct.

Schuelka (2013) revealed further criticism of the TIMSS as an international test of
achievement that outlines a narrow measure of specific academic subjects. According to
Schuelka (2013), the TIMSS, as other international assessments, entirely excludes
students with disabilities from participation as dictated by the international assessment
guidelines for desired target populations. This exclusion sends a message that students
with disabilities do not belong in the educational evaluation of achievement, which serves
to maintain the oppression of low expectations in reference to educational equity. The
U.S. policy requires that 95% of all students take achievement tests and receive
reasonable accommodations as necessary. Schuelka (2013) recommended that the TIMSS, as well as other international assessments, should follow the same policy and guidelines to ensure educational equity and evaluation of achievement. Despite the existing criticism regarding the TIMSS, many researchers and stakeholders concerned with mathematics achievement still find the study and results helpful.

U.S. Eighth-Grade Student Math Performance on TIMSS 2011

Mullis et al. (2012) reported that the U.S. eighth-grade student math performance on the TIMSS 2011 assessment was among the top 24 countries; 11 education systems within the countries had higher averages and 12 systems were not measurably different. The students of four countries performed higher than the U.S. students did, while student performance in six countries had averages not measurably different. The average set mean for all countries was 500. “The U.S. students’ average mathematics performance in 2011 of 509 was similar to the last TIMSS administration in 2007, wherein the average eighth-grade math performance was 508” (Mullis et al., 2012, p. 14). The U.S. eighth-grade student math performance was above average in the content domains of Algebra, Data and Chance, and Number, whereas student performance was below average in Geometry domain.

Furthermore, in their report, Mullis et al. (2012) related that the TIMSS 2011 international average scale score of eighth-grade students showed a gender difference that favored females, 469 versus 465. Few countries decreased their existing gender gap. Appendix C displays the international performance. There was no statistically significant
difference between the average score of U.S. eighth-grade males and females. Table 1 shows U.S. eighth-grade performance for each TIMSS administration since 1995.

Table 1

\textit{U.S. Eighth-Grade Student Math Performance for TIMSS 1995-2011}

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>490</td>
<td>498</td>
<td>502</td>
<td>507</td>
<td>508</td>
</tr>
<tr>
<td>Males</td>
<td>495</td>
<td>505</td>
<td>507</td>
<td>510</td>
<td>511</td>
</tr>
</tbody>
</table>

Academic Mindsets

Students’ beliefs and attitudes affect their motivation, engagement, learning and achievement. Academic mindsets provide a way of examining students’ attitudes and beliefs. Academic mindsets can be fixed or growth; however, growth mindsets aid in students’ perseverance and improvement of academic behaviors and achievement.

The 2010 William and Flora Hewlett Foundation Education Program outlined a focus centered on deeper learning, which supports the United States’ K-12 and community college approach to prepare students for a world that rapidly changes (Farrington, 2013). The Foundation Education Program detailed that “American public schools needed to ‘shift course’ in their teaching, learning, and assessment approaches. Approaches should ensure students develop the skills, knowledge, and competencies they will need to meet 21st century demands of life, work, and global citizenship” (Farrington,
2013, p. 2). The Hewlett Foundation (2010) added to its framework an addendum to develop academic mindsets in order to ensure deeper learning—the missing component that influences student engagement in learning.

Farrington (2013) defined academic mindsets as “the psycho-social attitudes or beliefs one has about oneself in relation to academic work” (p. 3). Students are compelled to engage or not engage in learning according to their attitudes and beliefs. Dweck, Walton, and Cohen (2011) stated, “Students need to think of themselves and school in certain ways in order to want to learn and in order to learn successfully” (p. 3).

According to Farrington (2013), academic mindsets emphasize a crucial set of learning variables:

First, positive academic mindsets are associated with the persistent academic behaviors that lead to learning . . . . student beliefs and attitudes have a profound effect on their engagement and learning in school. In this way, academic mindsets can be seen as precursors to or motivators for participation in deeper learning instructional activities. Second, academic mindsets are also likely products of deeper learning experiences. Ideally, over the course of students’ K-16 school experience, children and youth will come to see themselves as competent, productive people able to contribute meaningfully to their communities and the larger world. As students engage in deeper learning experiences and develop the other five deeper learning competencies, another likely outcome is the development of an efficacious sense of self, a valuing of education, and a positive disposition toward further learning. (pp. 3-4)
The support of developing academic mindsets is one of the best levers for increasing student ability to persevere and improve academic behavior. Noncognitive factors, skills, attitudes, beliefs, and strategies play a role in performance; however, most cognitive academic tests fail to measure these variables directly.

Farrington (2013) reported that students who work harder, engage in productive academic behaviors, and persevere to success when faced with obstacles are those with positive academic mindsets. Students who are likely to withdraw from behaviors for success have negative mindsets about school or even themselves. Those students with negative mindsets give up easily when facing obstacles, setbacks, or difficulty.

Farrington (2013) stated that academic mindsets are malleable factors subject to change through context and instruction. Therefore, developing positive academic mindsets requires improving academic perseverance and building deeper learning competence. Farrington (2013) presented four key mindsets associated with increasing perseverance, improving academic behaviors, and promoting higher grades. These are sense of belonging, belief in success, belief in effort, and belief in task value.

Sense of Belonging

Individuals need to feel a sense of belonging to the academic community. A basic need is the human need to belong, for individuals desire a connection with others, including adults and peers in academic settings. For humans, learning is a social construction that requires the sense of belonging as an important motivator. The sense of community allows students to view themselves as parts of both a social and academic community and, when experiencing difficulties and setbacks, students perceives those
obstacles as typical occurrences in learning, instead of feeling they do not belong. If a sense of belonging is absent, a student will generally withdraw and fail to interact, resulting in poor effort to learn (Farrington, 2013).

Belief in Success

 Individuals need to believe they can succeed in the task (Farrington, 2013). There is a strong association between a students’ belief in their skill at a task and academic perseverance. The likelihood of success and self-efficacy are more predictive of an individual’s academic performance than an individual’s actual measured ability. The anticipation of success creates a willingness to engage in a task. Students believing they will succeed at an academic task will more likely persevere longer in the task with strategies that improve their performance (Farrington, 2013). Therefore, it is necessary for the individual to possess the belief in his or her success in order to put forth needed effort. Students who believe they are unable to do something or students who expect failure will typically invest no effort and view the task as having no value.

Farrington (2013) cited studies of children’s self-efficacy confirming that students with greater math self-efficacy outperformed their peers with similar ability, whether they possessed high, medium, or low ability levels. Other studies of math performance have shown strong and direct effects of self-efficacy as being similar to those of ability. Self-efficacy effects have been similar across various contexts and academic domains.

Belief in Effort

 Students need to believe that effort results in growth of their ability and competence (Farrington, 2013). According to Dweck (2012), belief in a growth mindset
supports the notion that the brain is like a muscle that gets stronger through use. 

Believers in a growth mindset perceive challenges or mistakes in academics as opportunities to learn and further brain development. The mindset of growth is associated with mastery goal orientation “wherein students are motivated by wanting to learn as much as they can in order to master the material” (Farrington, 2013, p. 6).

In contrast, students with fixed mindsets believe intelligence is not in their control; instead, it is predetermined (Dweck, 2012). Students with fixed mindsets are likely to be performance-oriented, tending to give up quickly when faced with challenges or failure. These students often engage in task avoidance because of fear of public failure.

In a study of seventh-grade students with declining math scores, the random treatment group focused on developing a growth mindset. Students’ grades stabilized and resulted in “an average of 0.30 higher grade points than their peers who were in the control group” (Farrington, 2013, p. 7). Because of the intervention, students in the treatment group changed their understanding of the brain and their beliefs regarding intelligence, demonstrating the “malleability of student mindsets” (Farrington, 2013, p. 7).

Belief in Task Value

It is important that students believe that task hold value for them, for students will exert greater effort if they find value and connection with a task (Farrington, 2013). Human brains look for connections and relevance in order to process new information and ideas. For interpretation and valuation to occur, academic work must become a focus
of attention and have meaning. Tasks deemed by students to lack value require students to expend more energy to focus, complete, and recall information related to the task.

According to Farrington (2013), there are correlations between positive academic mindsets, increased academic perseverance, and improved academic performance. Academic mindsets, considered critical ‘levers’ in developing deeper learning competence for students, can increase student engagement and persistence. Dweck (2012) explained that educators play critical roles in building positive mindsets, for mindsets are subject to environmental influence, such as the school and classroom, wherein learning occurs. Positive mindsets influence content knowledge and student academic competence, but they also affect who students become as a result from educational experiences (Farrington, 2013).

Promoting Academic Mindsets

Farrington (2013) recommended that educators should not accept the myths that maintain students who struggle do not care about their education or failure. Failure has a negative and sometimes devastating effect on a student’s sense of self. Students who fail often feel incapable and inadequate, rather than prepared and equipped to be successful in the future.

Furthermore, in order to promote and sustain deeper learning, practitioners, researchers, and policymakers must receive aid in the inclusion of academic mindsets (Farrington, 2013). The hallmark of human nature is not in how much of a person’s identity is innate; it is in the human capacity to adapt, change, and grow. This debate becomes one of nature versus nurture to everyone, including students. Mindsets matter
whether an individual believes that core qualities are fixed by nature (fixed mindset) or that qualities can be developed (growth mindset). Dweck (2012) found that mindsets make a difference in academic success. Psychologists have studied mindsets or implicit theories as an individual’s lay beliefs about the nature of human attributes, such as personality and intelligence.

Fixed and Growth Mindsets

Some claim that human attributes are fixed traits. Believers of a fixed mindset might hold the view that each person has a fixed amount of intelligence incapable of being changed or that each person has a personality or moral character that nothing can alter. However, those with a growth mindset believe that all individuals can become more intelligent through effort and education as individuals take steps to develop their personality and moral character (Dweck, 2012).

Dweck (2012) shared that those who hold a fixed mindset about their own traits, such as intelligence, often avoid challenges in fear of showing themselves to be unintelligent. They also show less resilience in setbacks. Furthermore, they tend to interpret setbacks as implications of their lack of ability and become discouraged or defensive. Yet, those who hold a growth mindset believe it is possible to develop their qualities. They tend to seek challenging learning opportunities and show resilience in the face of setbacks. Those with growth mindsets view setbacks as not indications of self, but rather as parts of learning.

Teaching students to develop a growth mindset significantly boosts their motivation and achievement during challenging academic transitions (Dweck, 2012).
Growth mindsets can help prevent negative stereotypes from undermining achievement. A growth, nonlimited mindset liberates an individual to work effectively for longer periods and resist temptations during stressful times. Emphasizing growth increases intellectual achievement and creates a task to understand how learning takes places and how to maximize it. This requires an understanding of how people work and change, and how they can best fulfill their potential.

Fogarty (2016) outlined 13 principles for teaching, learning, and leading in Kindergarten through 12th grade. Fogerty (2016) further explained how students either “‘buy in’ or ‘opt out’ of the intelligence game” (p. 105). Students possess an understanding that they can develop and grow, which mirrors a growth mindset, or students believe they are smart or dumb, which is a static mindset. The static mindset leads students to believe nothing can change their inherited intelligence. Students’ decisions to “buy in” or “opt out” greatly affect their journey of learning. The decisions of students often make or break their cycle of success.

Fogarty (2016) referred to Coyle’s (2009) study of elite athletes, artists, and performers all over the globe, in which Coyle developed a theory referred as the talent code. Each case of performers noted as outstanding and extraordinary in every field contained three elements: master coaching with intense feedback for every learner, deep practice, and energy. Important to learning is the thinking of “If they can, so can I.” Dweck (2012) explored the ‘I can attitude’ and its inestimable value in K-12 classrooms for aspiring learners.
According to Dweck (2006a, 2006b), academic mindsets are important levers to support learning and change negative attitudes and beliefs about one’s ability. Growth mindsets provide attitudes and belief changes that foster ‘can do’ thinking and thereby, can increase achievement. Students’ sense of belonging and their beliefs in success, effort, and task value increase as growth mindsets traits are developed. Having a growth mindset provides traits that positively support intelligence, lead to a desire to learn, embrace challenges, persevere during obstacles, increase effort, learn from criticism, and gain inspiration from others’ success.

Mindsets and Resilience

Resilience is essential to success in life and school. Students’ mindsets affect their resilience academically and socially. Students must be prepared to respond to challenges with resilience. Parents and educators can support student resilience by helping students view challenges not as paths to failure, but as opportunities to overcome and be successful. Students should react with positive mindsets instead of reacting with negative emotions such as helplessness, refusal to continue, cheating, or aggressive behaviors. These mindsets can be strengthened, and during the change, resilience is promoted (Blackwell et al., 2007; Yeager, Trzesniewski, & Dweck, 2013).

Masten (2001) defined resilience as “good outcomes in spite of serious threats to adaptation or development” (p. 228). Yeager and Dweck (2012) provided a broader definition of resilience: “any behavioral, attributional, or emotional response to an academic or social challenge both positive and beneficial for development” (p. 303). Examples of negative student reactions to challenges are exhibitions of helplessness,
giving up, cheating, or aggressive retaliation (Yeager & Dweck, 2012). Good, Aronson, and Inzlich (2003) found middle school students who received weekly emails promoting a growth mindset showed significantly higher math and verbal achievement test scores. Good et al. (2003) also discovered test score improved by more than one standard deviation among middle school females in the area of mathematics.

Paunesku, Yeager, Romero, and Walton (2012) built upon Blackwell et al.’s (2007) study and created an intervention for community college students in developmental math courses. The intervention emphasized the potential to improve an individual’s math ability and outlined that “when people learn and practice new ways of doing algebra or statistics, it can grow their brains, regardless if they haven’t done well in math in the past” (Yeager & Dweck, 2012, p. 305). This research further provided a formula titled, “A Formula for Growing Your Brain: Effort + Good Strategies + Help from Others”. This formula explained that it is about more than effort. Students must also learn skills that allow utilization of their brains in smarter ways and practice the right way in order to improve. In support, scientists found that the brain grows more when learning something new and grows less when practicing things already known (Paunesku et al., 2012).

Challenges offer a way to get smarter instead of making students feel “dumb” (Yeager & Dweck, 2012). Therefore, educational reform efforts must also focus on addressing resilience in addition to increasing rigor in curriculum and instruction. Subtle messages from adults can affect student mindsets. Positive praise and comfort from parents and teachers to minimize struggles can lead students to develop more of a fixed
mindset that undermines resilience. Yeager and Dweck (2013) found that teachers with fixed mindsets made the comment to struggling students that they were just “not a math person” (p. 311). Following the comment, teachers would assign those students less math homework. These actions resulted in low improvement due to low expectations. Feedback given to those who do not perform well should help the struggling student see the need for better strategies and resilience. Feedback should also include praise for effort, strategies, focus, and persistence, rather than ability alone (Rattan, Good, & Dweck, 2012).

Mueller and Dweck (1998) outlined that praising students for being “smart” can promote a fixed mindset that does not respond with resilience during and following academic setbacks. It is important to praise students for their process and effort versus praising for intelligence. Mueller and Dweck (1998) found that students praised for process did significantly better after multiple trials, and the students asked for more challenging problems in the future.

The majority of students moving through the educational system face adversity, whether social or academic. Therefore, parents and educators must prepare students to respond to challenges with resilience. Self-esteem is not what is needed the most to face challenges; instead, students need mindsets that welcome challenges as opportunities to overcome with effort, strategies, learning, help from others, patience, and resilience (Yeager & Dweck, 2012). Students with growth mindsets have resilience to bounce back after facing obstacles and the resilience to embrace challenges as opportunities.
Impact of Mindsets

Mindsets have an impact and importance in promoting growth. Dweck (2006b) summarized her findings on the impact and nature of different mindsets. Decades of her research with subjects of various ages showed that when students develop what she referred to as a growth mindset, then students believe that their brains can grow from exercise and that intelligence and smartness can be learned. According to Dweck (2008), the brain forms new connections as effort changes. This activity, which is in the control of students, supports the growth mindset. Dweck’s studies revealed that 20% of students display mixed mindsets; 40% of students display a growth mindset, and 40% display a fixed mindset.

Dweck (2006b) further explained that as students participated in interventions moving them from a fixed to a growth mindset, the students began to perform immediately at higher levels in school. Blackwell et al. (2007) performed an intervention to promote growth mindsets with African American and Latino students in the U.S. who were transitioning to seventh grade. Many of the students had declining grades. Those students in the control group received eight sessions of intervention that included training in study skills. A growth mindset group received eight sessions of training in study skills, but also training in the growth mindset. The growth mindset message confirmed that effort changes the brain and forms new connections. This process was explained to be in students’ control. As a result, students in the growth mindset group experienced a halt in declining grades and began new pathways towards improvement and high achievement for students.
Similarly, Good et al. (2003) reported that intervention for seventh grade students resulted in a 4.5-point gain in mathematics achievement test scores and a 4-point gain in reading achievement. Good et al. (2003) noted a significant gender difference in mathematics within the control group without intervention; however, the gender gap was largely eliminated in the growth mindset group. The encouragement of growth mindsets are important, as demonstrated by the various studies that have resulted in mathematics achievement gains and improvement in grades for students.

Gender Differences and Mindsets

Differences in mindsets have been noted according to gender. Dweck (2006a, 2006b) discovered that fifth-grade females who scored high on IQ tests experienced more difficulty when given challenging work. However, the opposite was true for males. In another study, gender differences existed in mathematics among students with fixed mindsets. The studies further showed that females experience damage from messages of a fixed mindset, for it implies that some females are smart and some are not. Dweck (2006a, 2006b) attributed the messages as the cause for low numbers of women continuing in mathematics and science, highlighting the necessity to minimize gender differences in mindsets.

Ability Grouping and Mindsets

Leading educators of countries with students who are successful academically base their schooling and grouping practices on growth mindset messages and beliefs, communicating to students that learning is a process that requires time and effort (Sahlberg, 2011; Stigler & Hiebert, 1999). Students of countries, including England and
the United States, who score significantly low on international tests often base practices on ability that exist despite research showing “the plasticity of the brain and student ability to develop smartness through hard work and challenge” (Boaler, 2013, p. 145). Some schools continue to send messages of fixed ability, along with the message that some students have intelligence and some do not.

Boaler (2010) purported that mathematics is the subject area that communicates the strongest fixed ability messages and thinking. The awareness of the malleability of ability and the need for students to develop growth mindsets has strong implications for education. Similar to England, the United States groups students according to ability, especially in mathematics. The typical grouping occurs around seventh grade, wherein educators tell students that they are average, above average, or below average. In regards to their potential, students’ beliefs change in response to their group placement.

Dweck (2006a, 2006b) found that fixed mindset messages exist among students across the achievement range, and high-achieving females are the students most damaged by fixed ability beliefs. Fixed mindsets can hurt students who receive praise and references of being smart or clever. As soon as the students fail at a task, they infer that they are not smart after all. Fixed ability, often communicated in the practice of ability grouping, harms all students (Dweck, 2006a, 2006b).

Grouping according to ability sends messages to those with fixed mindset that their ability is static and as a result, they are grouped with others with the same fixed ability. Ability grouping reduces overall achievement for all students if it does not promote growth of ability and learning. Therefore, teaching high-level content to only
some students limits opportunities for success. Teachers who have fixed beliefs about learning and potential are often the source of ability grouping in schools.

Steele (2011) categorized ability grouping and mistakes as aspects of learning wherein research and practice are severely misaligned. Mistakes in the mathematics classroom are opportunities for learning and growth, rather than indications of low ability. Dweck (2012) asserted that every time a student makes a mistake in mathematics classes, new synapses form in the brain.

According to Boaler (2013), studies regarding learning and the brain have brought the field of education and neuroscience together. This union has produced critical findings that are important for schools:

- The plasticity of the brain: ability and intelligence grow with effort and practice.
- The importance of students’ mindsets for learning: when students believe that everybody’s ability can grow, their achievement improves significantly.
- The importance of teachers’ mindsets for teaching: when teachers believe that everybody’s ability can grow, and they give all students opportunities to achieve at high levels, students achieve at high levels.
- The effects of ability grouping in all its different forms: these grouping practices communicate damaging fixed mindset beliefs to students. (Boaler, 2013, p. 150)

Boaler (2013) referred to these as “the basis of the ‘Mindset Revolution’” (p. 150) that should be the center of all school improvement initiatives. Inequality in education
has resulted from fixed mindset beliefs. Fixed mindset beliefs harm minority students, females, and contribute to overall low achievement and participation. Therefore, it is of importance and urgency that schools begin to encourage beliefs of growth mindset. Schools need to move from grouping practices that send negative messages and labels. Negative messages must change to messages that promote teaching and learning that values the thinking, the struggles, and the various learning pathways of all students (Boaler, 2013).

**Mindsets and Math Learning**

Many studies have examined mindsets and math learning. Howard and Whitaker (2011) described a qualitative study that examined perspectives and experiences of successful developmental mathematics students. Previously unsuccessful, the students shared reflections of their change in mindset, which they described as a positive turning point. This turning point provided a shift in strategies that resulted in successful mathematics experiences (Howard & Whitaker, 2011).

In the United States, 60-75% of freshmen entering community colleges need remediation in mathematics (Howard & Whitaker, 2011). Students’ perceptions of their capability to be successful are highly influential to students’ performance. Understanding these influences can alter negative perspectives and provide information for instruction and student success.

Howard and Whitaker (2011) showed teacher actions and attitudes as major influences on a student’s belief orientation. Their study described experiences, attitudes, and strategies that the students viewed as ineffective in the past, along with the new
experiences, attitudes, and strategies that supported their success in learning basic math skills. One student shared being in his eighth-grade algebra class and feeling as if he “just couldn’t figure it out” (Howard & Whitaker, 2011, p. 4). Another student shared being in his algebra class, and as his teacher would explain things, he was thinking, “Man, that’s really hard. I can’t do that” (Howard & Whitaker, 2011, p. 4). The student further explained how that class experience remained with him since eighth grade, with the result that he viewed his performance in math as horrible. The latter student’s comment revealed his belief that he did not have the ability to learn mathematics.

Unfortunately, the students evidenced a helpless orientation as they reflected on their unsuccessful experiences (Howard & Whitaker, 2011). A third student felt like a failure because she “did not feel capable of learning” (Howard & Whitaker, 2011, p. 4), and a fourth student stated that math was “more than she could take” (p. 4). Students felt inadequate when they experienced negative turning points and debilitating academics. As students began to realize that they had to take and successfully pass mathematics courses for their college education and careers, a positive turning point occurred. Students explained that the turning point included decisions to go back to school, but more importantly, a change in their beliefs about their ability to have success in mathematics. Students were honest in sharing their dislike and hatred of learning mathematics. Some students even expressed that they were fearful of mathematics and that being in a mathematics classroom immediately made them feel stupid (Howard & Whitaker, 2011).
Howard and Whitaker (2011) asked students why they thought they were currently successful versus not being successful previously. Students shared changes attributing to motivation and their ability to see direct applications of the mathematics they were learning. One student realized the importance of mathematics outside of school. She stated that her mindset changed as she realized that math really does apply to the world. This mindset caused a desire to learn so that she could apply mathematics to her life. Another student voiced an attitude that made the difference in his success:

When you learn something and it’s interesting, you tend to like it, but when you have the mindset that you can’t learn something that’s presented, then it doesn’t become something interesting to you. It doesn’t become something that you like. (Howard & Whitaker, 2011, p. 8)

Students’ increased motivation was a result of a change in the mindset of their abilities.

In a study conducted by Dweck (2006b), students related they often felt that their lack of ability explained their mathematical inadequacy, resulting in their surrender and feelings of defeat. According to Dweck (2006b), the students had experienced two mindsets: one that was limited and one that fueled motivation. During the fixed mindset, motivation was lacking as they tried to learn mathematics, resulting in voices of fear and hatred. However, the growth mindset became evident when students believed that it was possible to expand their abilities if they made an effort to learn. When students’ beliefs moved to the growth mindset, they were motivated and became more active in their learning. Most of all students believed that they could be successful. The growth mindset provides a hopeful perspective that acknowledges that people may vary in their
talents, aptitudes, abilities and interests, but that growth with effort and application of learning is possible. In this vein, Howard and Whitaker (2011) recommended that teachers tailor learning experiences and communication to students in ways that foster a growth mindset. Growth mindsets helped students change their beliefs and attitudes towards their ability. Students experienced increased motivation and inspiration to learn as indicated by the research.

Mindsets and Math Achievement

Studies have revealed that mindsets aid in mathematics achievement and in the learning process. Mindsets can predict math achievement over time and change from fixed to growth through successful interventions. Dweck (2008) contended that growing research exists regarding the role of students’ mindsets in mathematics and science achievement. This research indicates that fixed and growth mindsets can play a role in the underachievement of women and minorities in mathematics and science. The research outlines that mindsets can predict math/science achievement over time; mindsets can contribute to discrepancies for women and minorities; mindsets can raise achievement through interventions that change mindsets; mindsets can reduce discrepancies in achievement; and educators play a key role in shaping students’ mindsets.

Dweck (2012) noted that students with the growth mindset were significantly more oriented toward learning goals than those students with fixed mindsets. Students with the growth mindset also showed stronger belief in the power of effort, believing that effort promoted ability regardless of the current level of ability. In contrast, students with
fixed mindsets believed that effort was necessary only for those who lacked ability, and often not successful for them. Finally, those with growth mindsets displayed more mastery-oriented reactions to setbacks, such as use of positive strategies and greater effort rather than effort withdrawal, negative strategies, and cheating. Students’ beliefs about their intelligence played a key role in how they achieved in math across the challenge of school transition (Dweck, 2012).

Grant and Dweck (2003) examined the achievement of college students in pre-med organic chemistry, a gateway to the premed curriculum. Students with the growth mindset were more oriented with learning goals. Conversely, students with fixed mindsets were more concerned with validating their intelligence (Grant & Dweck, 2003).

Grant and Dweck (2003) found that final grades in organic chemistry were higher for those with a growth orientation versus a fixed ability orientation. Furthermore, those with growth mindset used deeper learning strategies, while student failure to recover from poor grades was predictable for students with fixed mindsets. Among the students who held a fixed mindset, males outperformed females; among students holding a growth mindset, females slightly outperformed males. It is important to note that students who have a fixed mindset but simultaneously well prepared are at a disadvantage when faced with challenges (Dweck, 2008). According to research (Dweck, 2008), challenges can be opportunities to build growth mindset which lead to higher mathematics achievement.

Slosson stated, “Kids who struggle can learn math” (as cited in Checkley, 2006, p. 83). Slosson, a retired principal of an alternative school, designed a Math Lab for
students who had learned to dislike math. The students’ reasons for disliking mathematics were mainly that they did not understand it as easily as other students did. Slosson’s lab outlined six goals, the first and main goal of which was that students who complete the program would have “a more positive perception of mathematics” (Checkley, 2006, p. 84).

Evidence is increasingly indicating the role of mindsets in the underachievement of minorities and women in mathematics and science. Dar-Nimrod and Heine (2007) reported two experiments wherein college female students received explanations prior to completing a challenging math task. One group received the explanation of a fixed mindset manipulation that stated gender differences were of genetic basis. The other group received an explanation more of a growth mindset manipulation, stating that gender differences originated in the different experiences that males and females have had. Results of both experiments showed that females given the manipulation explanation of a fixed mindset performed significantly worse than females given the explanation of growth mindset manipulation (Dar-Nimrod & Heine, 2007).

Similarly, Good, Rattan, and Dweck (2007) studied several hundred females throughout their calculus course at an elite university to understand how mindsets influenced their beliefs of belonging in math, their desire to continue pursuing future math courses, and their math grades. The researchers found the females’ mindsets as important factors. Females with the growth mindset were less susceptible to effects of negative stereotypes. Furthermore, when encountering negative stereotypes, the females with growth mindsets continued to have a sense of belonging in math, continued to
pursue future math courses, and continued to earn high grades. In contrast, negative stereotypes affected females who held a fixed mindset more, and the females displayed an eroding sense of belonging in math. A decreased interest in future math courses and a decrease in final math grades accompanied this sense of not belonging (Good et al., 2007).

Educators’ Response/Teaching Mindsets

Some researchers believe that teachers’ responses and teaching of mindsets are important to students’ development of mindsets. Rheinberg (as cited in Dweck, 2010), a German researcher, measured mindsets of teachers at the beginning of the school year. Some teachers viewed their students as having fixed intelligence, and as educators, they had no influence on the students’ intellectual capabilities. Other teachers believed they were able to mold and enhance the intellectual skills of students. Rheinberg monitored student achievement over the school year (Dweck, 2010). Students of teachers with a fixed mindset entered and left the year as low achievers. However, students who entered the year as low achievers moved up to become moderate and even high achievers when instructed by teachers with a growth mindset. Teachers with a growth mindset are committed past conversation to finding ways so that every student can learn. They know that students can improve, encourage students to try harder, and give specific study and learning strategies suggestions to students (Dweck, 2010).

Adults may send messages that shape students’ mindsets. Mueller and Dweck (1998) studied the results of praising the intelligence of students versus praising their effort. Praising intelligence sends a fixed message that you are intelligent and that
intelligence is valued. However, praise for effort or strategy transmits the message of a
growth mindset and the possibility to build ability through effort. Remarkable
differences exist among students praised for intelligence versus those praised for effort
when encountering difficulty. Confidence and motivation are lost, and decreased
performance and shame regarding difficulty can occur for those praised for intelligence.
When facing difficulty, those students praised for effort continue to improve their
performance and often enjoy the challenge (Mueller & Dweck, 1998).

Teaching a growth mindset decreases or even closes achievement gaps (Dweck, 2010). Female students with growth mindsets experience grades and achievement test scores similar to male classmates. Messages that intelligence is fluid must be communicated to students, as well as heard by administrators and teachers. Cultures of growth mindsets are also necessary for administrators and teachers, for they encourage them to fulfill their potential to help their students fulfill their potential (Dweck, 2010).

Dweck (2010) discussed the beliefs that can have a striking impact on students’ achievement. She emphasized that equity in education is hard to capture, since it goes beyond brick, mortar, equal facilities, and resources. Individuals with the growth mindset believe that it is possible to develop intelligence through effort and instruction and that intellectual ability can grow for everyone. Importantly, students’ mindsets directly influence their performance and achievement.

Blackwell et al. (2007) shared the importance of teaching students to have growth mindsets that raise achievement test scores and grades. Various gaps persist of race, gender, and social class, and when compared globally, U.S. students rank poorly among
peers. U. S. students score below average in math literacy, ranking 30th among 54 nations. The average achievement level for students in the U.S. has not improved in the past 10 years (Organization for Economic Co-operation and Development, 2013).

Rattan et al. (2015) related extensive research that fosters improvement of students’ motivation, increase in grades, and reduction of racial, gender, and social class gaps through mindsets. Researchers are recognizing the need to utilize academic mindsets to promote math achievement for both females and males. Particularly among struggling students, academic mindsets can raise grades and motivation. Students, such as Blacks, Latinos, and females, who experience negative stereotypes in mathematics or science classes especially benefit from growth mindsets (Arson, Fried, & Good, 2002; Blackwell et al., 2007; Good et al., 2003). A growth mindset helps with engagement and achievement despite stereotypes. Students learn to focus on working hard in learning versus engaging in negative behaviors such as worrying and being defensive that might keep them from applying themselves.

Rattan et al. (2015) reported that with proper implementation, academic mindsets are powerful. They recommended disbanding curricula and structural interventions that are often expensive and ineffective. Instead, academic mindset interventions are low cost, supported by research, and capable of modification for large-scale utilization (Paunesku et al., 2015) and “highlight the critical role that the psychology of a student plays in determining educational outcomes” (Rattan et al., 2015, p. 721).

However, policymakers and other stakeholders have not taken advantage of its role in achievement. Rattan et al. (2015) acknowledged that mindsets are not the
universal cure or remedy, but contended they are indeed entry points with proper implementation. Federal, state, and local policy can help to lift the nation’s educational outcomes by leveraging mindsets. Improvement of educational outcomes is a necessity to “benefit individual students and to increase our national economic growth, social well-being, and global competitiveness” (Rattan et al., 2015, p. 721). Academic mindsets cannot answer all of the challenges facing educators, yet they will benefit students and thereby deserve greater attention from policymakers and other stakeholders.

Summary

This chapter presented a review of literature in reference to growth and fixed mindsets along with the potential role of academic mindsets upon the mathematics achievement of eighth-grade females. This included literature regarding gender stereotypes, math achievement, and middle school students’ attitudes toward mathematics. The chapter also highlighted the TIMSS study and its content domains. The chapter outlined the importance of student beliefs in success, beliefs in effort, and beliefs in task value, as well as the impact of mindsets along with the support of resilience. Also presented was literature showing the impact of mindsets in math learning and math achievement and the role of educators and other stakeholders in teaching and fostering of mindsets. Chapter 3 presents the research design and methodology.
CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

The purpose of this quantitative research study was to examine the relationship between academic mindsets and mathematics achievement of eighth-grade female students in the United States as measured by standardized mathematics scores. By examining quantitative archival data from the Trends in International Mathematics and Science Study (TIMSS) 2011, the following research questions and hypotheses guided this study:

1. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores?
   
   \[ H_{01} \]: There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores.

2. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics?
   
   \[ H_{02} \]: There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics.
In addition to examining archival data for female participants, the researcher reviewed descriptive data for males, shared later in this study. The gender differences of mindsets and mathematics achievement were of interest, although not a focus of this study. This chapter includes a description of the methods and procedures used in this study in order to examine the relationship, if any, existing among the variables under consideration. According to Salkind (2009), it is important to describe how the study will be conducted so others are able to replicate the research. Eight sections are included in this chapter: (a) research design; (b) study setting; (c) participants; (d) data collection; (e) data analysis; (f) assumptions and limitations; and (g) ethical considerations.

Research Design

This quantitative research utilized correlational research methods in order to quantify systematically the relationship that exists, if any, among identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores. Using questions on the TIMSS 2011 study, the researcher statistically examined archival data to determine if there is a relationship between identified academic mindsets and content domains and between academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores.

Fitzgerald, Rumrill, and Schenker (2004) described correlational research design as “an experimental method used for the purpose to test relationships between or among variables that are not manipulated” (p. 143). Correlational designs allow researchers to make logical inferences from nonexperimental data. The designs invoke “logic and theory while attempting to rule out reasonable alternative explanations” (Thompson,
Diamond, McWilliam, Snyder, & Snyder, 2005, p. 182). However, researchers are careful when examining variables for correlation to another variable. Although there may be a relationship between two variables, the relationship may not necessarily be a meaningful one.

This study, which included correlational research, sought to examine archival data statistically to determine if there is a common relationship among academic mindsets and mathematics achievement. A causal relationship was not in the scope of this study. Table 2 presents the variables under consideration.

Table 2

Research Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Mindsets (Value)</td>
<td>Mathematics Achievement</td>
</tr>
<tr>
<td>Academic Mindsets (Like)</td>
<td>Number</td>
</tr>
<tr>
<td>Academic Mindsets (Confident)</td>
<td>Algebra</td>
</tr>
<tr>
<td></td>
<td>Geometry</td>
</tr>
<tr>
<td></td>
<td>Data and Chance</td>
</tr>
</tbody>
</table>

Study Setting

Creswell (2007) stated the need for researchers to select individuals and sites that can inform “an understanding of the research problem and central phenomenon in the study” (p. 125). The administration of the TIMSS 2011 (Mullis, Martin, Foy, & Arora,
2012) occurred in participating countries required to draw samples of students who were near the end of fourth or eighth grade. The U.S. sample included the eighth grade of 501 schools. This study involves U.S. eighth-grade female participants from the following state public and private schools: Alabama, California, Colorado, Connecticut, Florida, Indiana, Massachusetts, Minnesota, and North Carolina.

Participants

Participants in the TIMSS 2011, administered in 2011 between April and June, included a U.S. sample of both public and private schools students. The schools, selected randomly, received weighting to represent the nation at grades 4 and 8. The U. S. national sample at grade 8 consisted of 501 schools and 10, 477 students (Mullis et al., 2012). States represented in this grade 8 sample included Alabama, California, Colorado, Connecticut, Florida, Indiana, Massachusetts, Minnesota, and North Carolina. This study included 5,164 eighth-grade females from the United States participating states.

Data Collection

The researcher examined archival data from the TIMSS 2011 study. The school records of each eighth-grade participant generated descriptive data. The data included each subject’s identification number, gender, and standardized mathematics achievement scores derived from TIMSS data.

The researcher also collected survey results for each student from the questionnaire consisting of items used previously in the TIMSS (see Appendix B). The Student Questionnaire used for grade 8 in the TIMSS 2011 study consists of additional questions that align to the three scales assessing student value, like, and confidence of
mathematics. The questions allow assessment of students who might have different beliefs in one or more of the scales assessed. Questionnaires and results from TIMSS have provided data used extensively by participating countries. The comparison of U.S. students at grade 8 has yielded international data since 1995 and has continued every four years. The questionnaire consists of items that provide clarity in student confidence, like, and value of mathematics. The International Association for the Evaluation of Educational Achievement (IEA) continues to sponsor the TIMSS, managed by the National Center for Education Statistics (NCES), a part of the U. S. Department of Education.

Mullis and Martin (2013) outlined the Assessment Frameworks for the most current study, along with the context questionnaire framework that effectively assesses and allows description of situations and factors that are associated with learning mathematics and science. The Assessment Frameworks have two dimensions: a content dimension and a cognitive dimension. The content dimension outlines the domains or subject matter assessed, such as number, algebra, geometry, and data and chance for eighth-grade students. The cognitive dimension outlines the domains or process of thinking, such as knowing, applying, and reasoning. Content domain titles for eighth grade differ from the fourth-grade domains, as the mathematics taught at each grade increases in difficulty.

Data Analysis

This quantitative study employed a correlation approach in order to examine the relationship that exists, if any, among identified academic mindsets and achievement as
measured by eighth-grade female standardized mathematics test scores. Fitzgerald et al. (2004) stated, “Correlational studies assess the strength of relationships as they occur or have occurred without experimental manipulation” (p. 143). The researcher considered the magnitude and direction of relationship among the variables using correlational designs. The researcher examined correlations for this study by mindsets related to value, like, confidence, and content domains to determine if the relationships differed for students based on these characteristics.

In order to examine the relationships, if any, that exist among the variables under consideration in this study and mathematics achievement, the researcher conducted Pearson r correlations. The level of significance for this study was set at .05, indicating a 5% chance of a Type I error. This is important because rejecting the null hypotheses infers the existence of a relationship between the considered variables, possibly leading to incorrect inferences regarding these relationships. Due to the sample population size and its close match to the overall population, the likelihood of a Type II error is not a major concern. Type II errors occur when the researcher fails to reject a false null hypothesis and does not take into account that the method of sampling included some bias. Each mindset scale is measured on a 4-point Likert scale (Agree a lot; Agree a little; Disagree a little; Disagree a lot).

Tables 3 and 4 display the alignment between Dweck’s (2015) characteristics of fixed and growth mindsets and the 2011 TIMSS eighth-grade mathematics survey statements. Many statements correlate with more than one trait and, according to a student’s response, the statement correlates with either the fixed or growth mindset.
Table 3

**Alignment between Dweck’s Fixed Mindset Traits and TIMSS Eighth-Grade Mathematics Survey**

<table>
<thead>
<tr>
<th>Dweck’s Fixed Mindset Trait</th>
<th>TIMSS Mathematics Survey Question&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence - is static</td>
<td>16c. Mathematics is not one of my strengths.</td>
</tr>
<tr>
<td>Leads to a desire - to look smart</td>
<td>16i. Mathematics is harder for me than any other subject.</td>
</tr>
<tr>
<td>Challenges – avoid challenges</td>
<td>14b. I wish I did not have to study mathematics.</td>
</tr>
<tr>
<td>Obstacles – gives up easily</td>
<td>16e. Mathematics makes me confused and nervous</td>
</tr>
<tr>
<td>Effort – see effort as fruitless</td>
<td>14c. Mathematics is boring.</td>
</tr>
<tr>
<td></td>
<td>15b. I think of things not related to the lesson.</td>
</tr>
<tr>
<td>Criticism – ignore useful negative feedback</td>
<td>b</td>
</tr>
<tr>
<td>Success of others – feel threatened by other’s success</td>
<td>16b. Mathematics is more difficult for me than for many of my classmates.</td>
</tr>
</tbody>
</table>

<sup>Note. a</sup> Reprinted with permission from “Student questionnaire<Grade 8>,” by TIMSS and PIRLS International Study Center, 2011. Copyright 2011 by International Association for the Evaluation of Educational Achievement.
<sup>b</sup>not applicable
Table 4

*Alignment between Dweck’s Growth Mindset Traits and TIMSS Eighth-Grade Mathematics Survey*

<table>
<thead>
<tr>
<th>Dweck’s Growth Mindset Trait</th>
<th>TIMSS Mathematics Survey Question&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence - can be developed</td>
<td>15a. I know what my teacher expects me to do.</td>
</tr>
</tbody>
</table>
| Leads to a desire - to learn | 14a. I enjoy learning mathematics.  
14e. I like mathematics.  
15e. My teacher gives me interesting things to do.  
16h. My teacher tells me that I am good at mathematics.  
16j. I think learning mathematics will help me in my daily life.  
16k. I need mathematics to learn other school subjects.  
16n. I would like a job that involves using mathematics. |
| Challenges – embrace challenges | 14d. I learn many interesting things in mathematics.  
16f. I am good at working out difficult mathematics problems. |
| Obstacles – persist in setbacks | 16g. My teacher thinks I can do well in mathematics with difficult material. |
| Effort – see effort as the path to mastery | 14f. It is important to do well in mathematics.  
15d. I am interested in what my teacher says.  
16a. I usually do well in mathematics.  
16l. I need to do well in mathematics to get into the university of my choice.  
16m. I need to do well in mathematics to get the job I want. |
| Criticism – learn from criticism | <sup>b</sup> |
| Success of others – find lesson and inspiration in others’ success | 15c. My teacher is easy to understand. |

<sup>Note. <sup>a</sup> Reprinted with permission from “Student questionnaire<Grade 8>,” by TIMSS and PIRLS International Study Center, 2011. Copyright 2011 by International Association for the Evaluation of Educational Achievement.  
<sup>b</sup>not applicable</sup>
Tables 3 and 4 contain similarities and differences regarding the alignment of Dweck’s mindset traits and TIMSS survey questions. Fixed mindset traits aligned with at least one TIMSS survey question, except in the instance of criticism and ignoring useful negative feedback. Growth mindset traits aligned with several TIMSS survey questions; however, similar to the fixed mindset, there was not a clear alignment of a TIMSS question regarding learning from criticism. Several TIMSS questions addressed the growth mindset in reference to developing intelligence and a desire to learn.

The researcher obtained survey results from TIMSS 2011, using software that allowed disaggregation of data to match each female participant of the sample. The data included gender, mathematics achievement, content domain achievement, and academic mindset survey results. All data were analyzed using SPSS 23 software program. The researcher examined the relationship among the independent and dependent variables outlined in Table 2. The researcher then calculated a correlation coefficient for each dependent variable and the corresponding independent variable, to determine if a statistically significant relationship exists between variables (Field, 2009).

Validity and Reliability of the TIMSS

Salkind (2009) stated that validity refers to the effectiveness of the study results o measure what the researcher intended to measure, which allows the researcher to reach valid conclusions. This study focused on the relationship among academic mindsets and mathematics achievement of eighth-grade female students. The intent of the study was to identify the strength of relationships that potentially exist among the independent and dependent variables. The study did not lend itself to determining cause. Internal validity
is applicable with experimental research and only relevant in studies that try to establish a causal relationship; the question of internal validity is therefore not relevant to this study.

External validity refers to the generalization to the overall population or other contexts as it refers to research findings. A researcher can control external validity threats by choosing effective representation of the overall population under study. Field (2009) explained that sample size impacts the generalizability of the study: larger samples more accurately reflecting the whole population. Therefore, it is reasonable to assume that findings of this study are generalizable to other students. The consistency of producing the intended outcomes by methods or measures used in the research design refers to reliability. Salkind (2009) contended a method is considered reliable if it produces the same results recurrently.

Kastberg, Roey, Ferraro, Lemanski, and Erberber (2013) stated that achievement results from TIMSS are reported using a scale from 0 to 1,000, with a scale average of 500 and standard deviation of 100. Results since the first administration and each subsequent administration are comparable because achievement scores in each assessment are placed on a scale that does not depend on the list of education systems participating in a particular year. Student responses are assigned sampling weights to ensure their representation matches their actual percentage of the school population in the assessed grade. The assignment of sampling weights aid in adjustments for over- or underrepresentation during the sampling of a particular group. Sampling weights are necessary to compute nationally representative estimates that are solid and logically valid.
The Pearson Company, which receives assessments and questionnaires following their completion at a school, accumulated and organized the TIMSS data. The company then records receipt of materials, scores the open-ended responses portions in the assessment, codes the multiple-choice assessment items and questionnaire responses, and creates data files. The Process Control System and the Work Flow Management system are two systems used to monitor procession and receipt of assessments.

Limitations, Assumptions, and Design Controls

This study assumed that each female student in the study fully participated in the TIMSS questionnaires without difficulty. The researcher’s ability to assess information for each participant in the study was limited to data available utilizing the TIMSS database. Furthermore, the TIMSS study has received criticism, as Choi, Lee, and Park (2015) outlined allegations of the assessment not being applicable to existing school programs, seldom utilized, and inconsiderate of cultural context. Ferrini-Mundy and Schmidt (2005) outlined the need for collaboration to conduct research projects that would be applicable to existing school systems. According to Schuelka (2013), further criticism of the TIMSS concerned the narrow measure of academic subjects, math and science, assessed by the international test of achievement. Schuelka (2013) also reported the exclusion of students with disabilities does not ensure inclusive evaluation of achievement and educational equity.

Ethical Considerations

Kapp (2006) stated ethics in research should focus on safety of participants, informed consent, and confidentiality. These considerations are central to a study to
ensure the accuracy of results while simultaneously protecting the rights of individuals participating. These considerations were not central to this study that was not experimental, for it utilized only participant data; therefore, participant safety was protected.

Summary

This chapter presented the methodology, research design, and selection of participants. The researcher utilized quantitative methodology to examine the relationship between academic mindsets and mathematics achievement of eighth-grade female students as measured by standardized mathematics scores. Correlational research methods were used to determine if any relationship existed between identified mindsets and achievement of eighth-grade United States female students from both public and private schools. The chapter also addressed validity, reliability, and ethical considerations. The researcher examined archival data to determine the existence, if any, of a correlation among academic mindsets and mathematics achievement along with achievement in content domains. Data analysis included determination of a relationship, if any, that exists among female mindsets and female mathematics achievement. The researcher also analyzed correlations regarding the relationship of mindsets and achievement in the individual content domains. Chapter 4 presents the results of the data collection, and Chapter 5 provides conclusions, implications, and recommendations for future research.
CHAPTER 4
RESULTS

This chapter provides a detailed description and analysis of the data to determine if a statistically significant correlation exists between identified academic mindsets and achievement as measured by U. S. eighth-grade female standardized mathematics tests scores from TIMSS 2011. Additionally, achievement in content domains of mathematics is analyzed to determine if a statistically significant correlation exists among identified academic mindsets and content domain achievement.

This quantitative study examined archival data for 5,275 eighth-grade females from the United States. This chapter begins with a review of the study’s purpose and guiding research questions. Calculation of the Pearson product correlation coefficient for each research question determined if a relationship existed among the variables under consideration and established whether any existing relationship was meaningful. Salkind (2009) outlined the correlation coefficient as one of the most frequently used measures to assess the degree of relatedness and determine the correlation of two or more variables; however, it does not provide causation. The researcher also examined data for 5,164 eighth-grade males to establish a context for female achievement.

Purpose of the Study Reiterated

The purpose of this study was to determine if there is a significant statistical correlation of academic mindsets to mathematics achievement and content domain
achievement of eighth-grade female students. The participants in this study were United States eighth-grade females who participated in the TIMSS 2011. This study contributes to the literature, possibly filling gaps that exist in the area of mathematics achievement from the viewpoint of academic mindsets. The results of this study have the potential to aid the needs of the population identified, lead to interventions to change fixed mindsets that are negative regarding mathematics, and increase female participation in higher-level mathematics courses and STEM careers.

Research Questions and Related Null Hypotheses

The following research questions and subsequent null hypotheses were tested during this study. The Findings section of this chapter addresses each question separately.

1. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores?

   \( H_{01} \): There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores.

2. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics?
H₀2: There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics.

Descriptive Data

The subjects in this study included 5,275 United States eighth-grade female students who participated in the TIMSS 2011. Table 5 provides a visual representation of the descriptive statistics gathered during data collection.

Table 5

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall TIMSS Math Score</td>
<td>5,275</td>
<td>508.23</td>
<td>74.270</td>
</tr>
<tr>
<td>TIMSS Subscales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td>5,275</td>
<td>516.17</td>
<td>71.690</td>
</tr>
<tr>
<td>Data and Chance</td>
<td>5,275</td>
<td>524.16</td>
<td>98.910</td>
</tr>
<tr>
<td>Number</td>
<td>5,275</td>
<td>508.80</td>
<td>81.810</td>
</tr>
<tr>
<td>Geometry</td>
<td>5,275</td>
<td>481.74</td>
<td>80.490</td>
</tr>
<tr>
<td>Mindset Scales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value Mathematics</td>
<td>5,230</td>
<td>1.61</td>
<td>0.677</td>
</tr>
<tr>
<td>Like Mathematics</td>
<td>5,236</td>
<td>2.23</td>
<td>0.744</td>
</tr>
<tr>
<td>Am Confident in Mathematics</td>
<td>5,236</td>
<td>2.14</td>
<td>0.755</td>
</tr>
</tbody>
</table>

The first row reveals the overall TIMSS mean math score and standard deviation for the 5,275 U.S. female students. The students’ mean mathematics score was 508.23,
which is above the TIMSS average score of 500. Subsequent rows present students’ average subscale scores in each content domain. The highest achievement is evident in the content domain of Data and Chance, whereas the lowest achievement scores are in the Geometry domain. In comparing Mindset scales achievement, the number of students varied due to incomplete survey responses for all participants.

Table 6 presents the descriptive statistics for eighth-grade United States male student performance on the TIMSS in 2011. The first row reveals the overall TIMSS math score for the 5,164 U.S. male students. The students’ mean mathematics score was 510.47, which is above the TIMSS average score of 500. Subsequent rows present students’ average subscale scores in each content domain.

Table 6

*Descriptive Statistics for TIMSS 2011 Overall Score, Subscales, and Mindset Scales of Eighth-Grade Male Participants*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall TIMSS Math Score</td>
<td>5,164</td>
<td>510.47</td>
<td>77.10</td>
</tr>
<tr>
<td>TIMSS Subscales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td>5,164</td>
<td>509.96</td>
<td>73.820</td>
</tr>
<tr>
<td>Data and Chance</td>
<td>5,164</td>
<td>528.81</td>
<td>101.570</td>
</tr>
<tr>
<td>Number</td>
<td>5,164</td>
<td>518.83</td>
<td>85.240</td>
</tr>
<tr>
<td>Geometry</td>
<td>5,164</td>
<td>489.06</td>
<td>81.700</td>
</tr>
<tr>
<td>Mindset Scales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value Mathematics</td>
<td>5,088</td>
<td>1.57</td>
<td>0.672</td>
</tr>
<tr>
<td>Like Mathematics</td>
<td>5,100</td>
<td>2.18</td>
<td>0.743</td>
</tr>
<tr>
<td>Am Confident in Mathematics</td>
<td>5,098</td>
<td>2.02</td>
<td>0.734</td>
</tr>
</tbody>
</table>
Similar to eighth-grade females, the highest achievement for males is evident in the content domain of Data and Chance, whereas the lowest achievement scores are in the Geometry domain. In comparing Mindset scales achievement, the number of students varied due to incomplete survey responses for all participants. The highest mean score for eighth-grade males was in the Like Mathematics mindset scale, as also found for eighth-grade females.

*Figure 1* depicts the overall TIMSS scores and content domain achievement for eighth-grade United States females.

*Figure 1. Female math achievement on the 2011 TIMSS*

The overall TIMSS scores and content domain achievement depicts the highest achievement in the content domain of Data and Chance. Geometry is the content domain wherein the overall TIMSS scores were the lowest.
Figure 2 depicts the mindset scores of Value, Like and Confident for eighth-grade United States females.

![Female Mindset scores](image)

Figure 2. Female mindset scores on the 2011 TIMSS

As depicted, Like mindset scores were highest for females than the mindset scales of Value and Confident. Female mindset scores were the lowest for Value. Lower scores are better, for lower scores depict students liking, valuing, or being more confident in mathematics. According to Mullis, Martin, Foy, and Arora (2012), TIMSS 2011 utilized a scoring range of 1-3 for Like, Value, and Confident: 1 = I Like learning math/I Value learning math/I am Confident in Math; 2 = I somewhat like learning math/ I somewhat
value math/ I am somewhat confident in math; and 3 = I do not like learning math/I do not value math/I am not confident in math.

Findings

The findings of this study resulted from analyzing data from the sample population taken from archival data of TIMSS 2011 using the Statistical Package for Social Sciences (SPSS) software package, Version 23. The data included the participants’ gender, mathematics achievement, content domain achievement, and survey results from the Mindset scales of Value, Like, and Confident. The level of significance was set at .05 for all statistical analyses. Where statistically significant correlations were found, effect sizes were calculated based on the coefficient of determination ($r^2$), which is approximately defined as small with $r^2 = .01$, medium with $r^2 = .09$, and large with $r^2 = .25$ (Warner, 2008). Effect size is provided to further explain variability in correlations. Cohen (2003) explained that statistical significance only indicates that the relationship exists at all; therefore, further analysis is necessary in order to determine if the findings are meaningful.

Research Question 1

The first research question was: Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores? In order to answer the question, the null hypothesis was developed that would address the question from the perspective of the entire sample population, regarding academic mindsets and achievement of eighth-grade
female standardized mathematics test scores. Table 7 depicts the relationship between each female mindset scales, overall TIMSS math score and Mindset Effect Size.

Table 7

Pearson’s r for the Relationship between Female Students’ Mindset Scales, Overall TIMSS Math Score, and Mindset Effect Size

<table>
<thead>
<tr>
<th>Scale</th>
<th>Value</th>
<th>$r^2$</th>
<th>Like</th>
<th>$r^2$</th>
<th>Confident</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall TIMSS score</td>
<td>-.121**</td>
<td>.015</td>
<td>-.192**</td>
<td>.037</td>
<td>-.390**</td>
<td>.152</td>
</tr>
</tbody>
</table>

*Note.* **Correlation is significant at the $p < .01$ level.

Using Pearson’s $r$, the correlation between student responses on each mindset scale (Value, Like, and Confident) and the overall math score on the TIMSS was calculated. The relationship between the Value mathematics mindset and the overall TIMSS math score was significant: $r(5228) = -.121$, $p < .01$. The results indicate that a negative relationship exists between how much value students place on learning math and their overall performance on the TIMSS math test. The value scale was reverse-coded and thereby, lower scores support students valuing mathematics, as scores increase, students find less value in mathematics. Students who reported valuing or somewhat valuing math (as indicated by lower scores on the Value Mathematics mindset scale) performed higher on the overall TIMSS math test than those students who reported not valuing math.

The relationship between the Like Mathematics mindset and the overall TIMMS math score was significant, $r(5234) = -.192$, $p < .01$. The results indicate that a negative
A relationship exists between how well students like math and their overall performance on the TIMMS. Students who report liking math or somewhat liking math (as indicated by lower scores on the “Like Mathematics” mindset scale) performed higher on the overall TIMMS math test than those students who reported not liking math.

The relationship between the Confident Mathematics mindset and the overall TIMMS math score was also significant, $r(5234) = -0.390, p < .01$. The results indicate that a negative relationship exists between a student’s confidence level and overall performance on the TIMMS math test. Students reporting being confident or somewhat confident in their math abilities (as indicated by lower scores on the Confident Mathematics mindset scale) had higher scores on the overall TIMMS math test than those students reporting not at all being confident in their math abilities.

The effect size results for each mindset scale indicate the lowest effect size of 2% for Value and 4% for Like. The effect size for Confidence was medium as indicated by 15%. Even though Pearson $r$ correlations were significant, the effect sizes were very small for Value and Like. Confidence is important as students encounter mathematics learning.

Research Question 2

The second research question was: Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics? In order to answer the second research question, the null hypothesis was developed that would address the question from the perspective of the entire sample.
population regarding identified academic mindsets and achievement in relation to content
domains of mathematics. Table 8 depicts TIMSS subscale and mindset correlations for
females. Using Pearson’s $r$, the correlations between student responses on each mindset
scale (Value, Like, and Confident) and the math score on each of the TIMSS subscales
were calculated.

Table 8

*Pearson’s $r$ for Each TIMSS Subscale and Mindset: Females*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>$r^2$</th>
<th>Like</th>
<th>$r^2$</th>
<th>Confident</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra</td>
<td>-.121**</td>
<td>.015</td>
<td>-.229**</td>
<td>.05</td>
<td>-.398**</td>
<td>.16</td>
</tr>
<tr>
<td>Data and Chance</td>
<td>-.076**</td>
<td>.006</td>
<td>-.136**</td>
<td>.02</td>
<td>-.310**</td>
<td>.10</td>
</tr>
<tr>
<td>Number</td>
<td>-.087**</td>
<td>.008</td>
<td>-.196**</td>
<td>.04</td>
<td>-.380**</td>
<td>.14</td>
</tr>
<tr>
<td>Geometry</td>
<td>-.133**</td>
<td>.018</td>
<td>-.184**</td>
<td>.03</td>
<td>-.363**</td>
<td>.13</td>
</tr>
</tbody>
</table>

*Note.* **Correlation is significant at the $p < .01$ level.

Value Mindset Scale for females and TIMSS Mathematics Subscales relationship.

This section relates the relationship between the Value Mindset Scale for females and the
TIMSS Mathematics Subscales. The TIMSS Mathematics Subscales include Algebra,
Data and Chance, Number, and Geometry. Using Pearson’s $r$, the correlations between
student responses on the Value mindset scale and the math score on each of the TIMSS
subscales were calculated.
**Algebra.** The relationship between the Value mindset and the Algebra Subscale score was also significant, \( r(5228) = -0.121, p < .01 \). The results indicate that a negative relationship exists between how much a student values math and her performance on the Algebra Subscale, meaning that the lower student scores on the Value questionnaire result in higher scores on the math test. Students reporting valuing or somewhat valuing math had higher scores on the Algebra portion of the TIMMS math test than those students reporting that they do not value math, because lower scores on the Value questionnaire indicate higher levels of valuing math. For the Value Mindset scale and Algebra, \( r^2 = .015 \), which means that the variance in scores on the Value mindset scale explains slightly less than 2% of the variance in the Algebra scores. Therefore, other variables explain more than 98% of the differences found in the Algebra scores of eighth-grade females.

**Data and Chance.** The relationship between the Value mindset and the Data and Chance Subscale score was significant, \( r(5228) = -0.076, p < .01 \). The results indicate that a negative relationship exists between how much a student values math and her performance on the Data and Chance Subscale of the TIMMS math test, meaning that lower scores on the Value mindset scale result in higher scores on the math test. Students reporting valuing or somewhat valuing math (indicated by a lower score on the Value questionnaire) had higher scores on the Data and Chance portion of the TIMMS math test than those students reporting that they do not value math (indicated by a higher score on the Value questionnaire). For the Value Mindset scale and Data and Chance, \( r^2 = .006 \), which means that the variance in scores on the Value mindset scale explains slightly less
than 1% of the variance in the Data and Chance scores. Therefore, other variables explain more than 99% of the differences found in the Data and Chance scores of eighth-grade females.

**Number.** The relationship between the Value mindset and the Number Subscale score was significant, $r(5228) = -0.087, p < .01$. The results indicate that a negative relationship exists between how much a student values math and her performance on the Number Subscale of the TIMMS math test, meaning that lower scores on the Value mindset scale result in higher scores on the math test. Students reporting valuing or somewhat valuing math (indicated by a lower score on the Value questionnaire) had higher scores on the Number portion of the TIMMS math test than those students reporting that they do not value math (indicated by a higher score on the Value questionnaire). For the Value Mindset scale and Number, $r^2 = .008$, which means that the variance in scores on the Value mindset scale explains slightly less than 1% of the variance in the Number scores. Therefore, other variables explain more than 99% of the differences found in the Number scores of eighth-grade females.

**Geometry.** The relationship between the Value mindset and the Geometry Subscale score was significant, $r(5228) = -0.133, p < .01$. The results indicate that a negative relationship exists between how much a student values math and her performance on the Geometry Subscale of the TIMMS math test, meaning that lower scores on the Value mindset scale result in higher scores on the math test. Students reporting valuing or somewhat valuing math (indicated by a lower score on the Value questionnaire) had higher scores on the Geometry portion of the TIMMS math test than
those students reporting that they do not value math (indicated by a higher score on the Value questionnaire). For the Value Mindset scale and Geometry, $r^2 = .018$, which means that the variance in scores on the Value mindset scale explains slightly less than 2% of the variance in the Geometry scores. Therefore, other variables explain more than 98% of the differences found in the Geometry scores of eighth-grade females.

Like Mindset Scale for females and TIMSS Mathematics Subscales relationship. This section relates the relationship between the Like Mindset Scale and the TIMSS Mathematics Subscales. The TIMSS Mathematics Subscales include Algebra, Data and Chance, Number, and Geometry. Using Pearson’s $r$, the correlations between student responses on the Like mindset scale and the math score on each of the TIMSS subscales were calculated.

*Algebra.* The relationship between the Like mindset and the Algebra Subscale score was significant, $r(5234) = -.229$, $p < .01$. The results indicate that a negative relationship exists between how much a student likes math and her performance on the Algebra Subscale, meaning that the lower scores on the Like questionnaire result in higher scores on the math test. Students who reported liking or somewhat liking math had higher scores on the Algebra portion of the TIMMS math test than those students reporting not at all liking math, because lower scores on the Like questionnaire indicate more math confidence. For the Like Mindset scale and Algebra, $r^2 = .05$, which means that the variance in scores on the Like mindset scale explains approximately 5% of the variance in the Algebra scores. Therefore, other variables explain 95% of the differences found in the Algebra scores of eighth-grade females.
Data and Chance. The relationship between the Like mindset and the Data and Chance Subscale score was significant, \( r(5234) = -0.136, p < .01 \). The results indicate that a negative relationship exists between how much a student likes math and her performance on the Data and Chance Subscale of the TIMMS math test, meaning that lower scores on the Like mindset scale result in higher scores on the math test. Students reporting liking or somewhat liking math (indicated by a lower score on the Like questionnaire) had higher scores on the Data and Chance portion of the TIMMS math test than those students reporting that they do not value math (indicated by a higher score on the Like questionnaire). For the Value Mindset scale and Data and Chance, \( r^2 = .02 \), which means that the variance in scores on the Value mindset scale explains 2% of the variance in the Data and Chance scores. Therefore, other variables explain 98% of the differences found in the Data and Chance scores of eighth-grade females.

Number. The relationship between the Like mindset and the Number Subscale score was significant, \( r(5234) = -0.196, p < .01 \). The results indicate that a negative relationship exists between how much a student likes math and her performance on the Number Subscale of the TIMMS math test, meaning that lower scores on the Like mindset scale result in higher scores on the math test. Students reporting liking or somewhat liking math (indicated by a lower score on the Like questionnaire) had higher scores on the Number portion of the TIMMS math test than those students reporting that they do not value math (indicated by a higher score on the Like questionnaire). For the Like Mindset scale and Number, \( r^2 = .04 \), which means that the variance in scores on the Like mindset scale explains approximately 4% of the variance in the Number scores.
Therefore, other variables explain 96% of the differences found in the Number scores of eighth-grade females.

*Geometry.* The relationship between the Like mindset and the Geometry Subscale score was significant, $r(5234) = -.184, p < .01$. The results indicate that a negative relationship exists between how much a student likes math and her performance on the Geometry Subscale of the TIMMS math test, meaning that lower scores on the Like mindset scale result in higher scores on the math test. Students reporting liking or somewhat liking math (indicated by a lower score on the Like questionnaire) had higher scores on the Geometry portion of the TIMMS math test than those students reporting that they do not like math (indicated by a higher score on the Like questionnaire). For the Like Mindset scale and Geometry, $r^2 = .03$, which means that the variance in scores on the Like mindset scale explains approximately 3% of the variance in the Geometry scores. Therefore, other variables explain 97% of the differences found in the Geometry scores of eighth-grade females.

*Confident Mindset Scale for females and TIMSS Mathematics Subscales* relationship. This section relates the relationship between the Confident Mindset Scale and the TIMSS Mathematics Subscales. The TIMSS Mathematics Subscales include Algebra, Data and Chance, Number, and Geometry. Using Pearson’s $r$, the correlations between student responses on the Confident mindset scale and the math score on each of the TIMSS subscales were calculated.

*Algebra.* The relationship between the Confidence mindset and the Algebra Subscale of the TIMMS math score was also significant, $r(5234) = -.398, p < .01$. The
results indicate that a negative relationship exists between student confidence level and performance on the Algebra Subscale, meaning that lower scores on the Confidence questionnaire result in higher scores on the math test. Students reporting being confident or somewhat confident in their math abilities had higher scores on the Algebra portion of the TIMMS math test than those students reporting not at all being confident in their math abilities, because lower scores on the Confidence questionnaire indicate more math confidence. For the Confident Mindset scale and Algebra, $r^2 = .16$, which means that the variance in scores on the Confident mindset scale explains approximately 16% of the variance in the Algebra scores. Therefore, other variables explain 84% of the differences found in the Algebra scores of eighth-grade females.

*Data and Chance.* The relationship between the Confidence mindset and the Data and Chance Subscale of the TIMMS math score was also significant, $r(5234) = -.310, p < .01$. The results indicate that a negative relationship exists between student confidence level and performance on the Data and Chance Subscale, meaning that lower scores on the Confidence questionnaire result in higher scores on the math test. Students reporting being confident or somewhat confident in their math abilities (as indicated by lower scores on the Confidence questionnaire) had higher scores on the Data and Chance portion of the TIMMS math test than those students reporting not at all being confident in their math abilities (as indicated by higher scores on the Confidence questionnaire). For the Confident Mindset scale and Data and Chance, $r^2 = .10$, which means that the variance in scores on the Confident mindset scale explains approximately 10% of the
variance in the Data and Chance scores. Therefore, other variables explain 90% of the
differences found in the Data and Chance scores of eighth-grade females.

**Number.** The relationship between the Confidence mindset and the Number
Subscale of the TIMMS math score was also significant, \( r(5234) = -.380, p < .01 \). The
results indicate that a negative relationship exists between student confidence level and
performance on the Number Subscale, meaning that lower scores on the Confidence
questionnaire result in higher scores on the math test. Students reporting being confident
or somewhat confident in their math abilities (as indicated by lower scores on the
Confidence questionnaire) had higher scores on the Number portion of the TIMMS math
test than those students reporting not at all being confident in their math abilities (as
indicated by higher scores on the Confidence questionnaire). For the Confident Mindset
scale and Number, \( r^2 = .14 \), which means that the variance in scores on the Confident
mindset scale explains approximately 14% of the variance in the Number scores.
Therefore, other variables explain 86% of the differences found in the Number scores of
eighth-grade females.

**Geometry.** The relationship between the Confidence mindset and the Geometry
Subscale of the TIMMS math score was also significant, \( r(5234) = -.363, p < .01 \). The
results indicate that a negative relationship exists between student confidence level and
performance on the Geometry Subscale, meaning that lower scores on the Confidence
questionnaire result in higher scores on the math test. Students reporting being confident
or somewhat confident in their math abilities (as indicated by lower scores on the
Confidence questionnaire) had higher scores on the Number portion of the TIMMS math
test than those students reporting not at all being confident in their math abilities (as indicated by higher scores on the Confidence questionnaire). For the Confident Mindset scale and Geometry, $r^2 = .13$, which means that the variance in scores on the Confident mindset scale explains approximately 13% of the variance in the Geometry scores. Therefore, other variables explain 87% of the differences found in the Geometry scores of eighth-grade females.

**Mindset Effect Size**

*Figure 3* depicts the mindset effect size for Value, Like, and Confident for eighth-grade females.

![Mindset Effect Size - Females](image)

*Figure 3*. Mindset effect size for females on TIMSS 2011

Mindset effect sizes are shown for Value, Like, and Confident in the content domains of Algebra, Data and Chance, Number, and Geometry. The mindset effect size
is lowest in Value: Algebra (2%), Data & Chance (1%), Number (1%), and Geometry (2%). The low effect size suggests that variables other than mindset affect females valuing mathematics in each content domain. Although correlations are significant, the mindset effect sizes ranged from small to medium-medium large. In all four content domains for Like, the mindsets effect sizes were small: Algebra (5%), Data & Chance (2%), Number (4%), and Geometry 3%). Mindset effect sizes were largest in Confidence for each content domain: Algebra (16%), Data and Chance (10%), Number (14%) and Geometry (13%).

Summary

The researcher conducted Pearson’s $r$ correlation analyses to determine if any statistically significant relationships existed among the variables under consideration. A coefficient of determination was calculated by squaring the correlation coefficient found in the Pearson correlation analyses. Using this statistical data, the researcher determined whether to reject the null hypotheses for each of the two research questions. The data indicated that there was sufficient evidence to reject the null hypotheses associated with both research questions. Negative correlations indicate that as scores on the Value, Like, and Confident subscales in mathematics decrease towards agreeing with academic mindsets of growth, the academic achievement increases. Negative correlations were also found between Value, Like, and Confident in math scale scores and the content domain achievement. However, while all negative correlations were found to be significant at $p < .01$, effect sizes were small in each content domain for Value and Like mindsets. However, the effect sizes were medium to medium-large in each content
domain for Confidence; thereby, found meaningful. Chapter 5 provides an in-depth description of these phenomena, as well as a summary of the study, conclusions, implications, and recommendations for further study.
CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to examine barriers that impacted the mathematics academic achievement of eighth-grade females who participated in the Trends in International Mathematics and Science Study (TIMSS) of 2011. Stoltzfus (2016) shared, “Examining early gendered patterns in math can shed new light on differences in young girls' and boys' school experiences that may shape their later choices and outcomes” (para. 12). Furthermore, Stoltzfus (2016) emphasized “the need to further unpack the causes of early gender gaps in math, including the role that teacher expectations and students’ learning behaviors and problem-solving approaches may play in their development” (para. 13).

Mathematics continues to be a concern for our nation, states, school systems, and local schools. The increasing quantification of the world makes it essential for students to possess effective mathematical and technological skills necessary for continued study, professional careers and occupations, and everyday life.

Student beliefs and attitudes are important to mathematical learning, resilience, and achievement. As students develop growth mindsets, they are better equipped to see mistakes as opportunities to learn further and view obstacles as challenges rather than defeat. Educational policymakers, stakeholders, teachers, students, and families need to understand the significant relationship between mindsets and academic achievement.
Therefore, it is important to investigate this relationship. This chapter provides a reiteration of the research questions, a summary of this study; a discussion of major findings, conclusions, implications; and recommendations for future research.

Research Questions and Hypotheses Reiterated

1. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores?

\( H_01: \) There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores.

2. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics?

\( H_02: \) There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics.

Summary of Study

This study was conducted by examining identified academic mindsets and mathematics achievement of U.S. eighth-grade female students as measured by standardized mathematics scores and student questionnaires from TIMSS 2011. The researcher examined the correlations among variables of the academic mindsets of Value, Like, and Confident and academic achievement. Further correlations were examined
among academic mindsets and achievement in the four content domains of Algebra, Data and Chance, Number, and Geometry. The archival data were examined and correlations conducted to determine if relationships existed between variables outlined. The next section provides a discussion of the findings of this study.

Discussion of Findings

In examining the results of the Pearson $r$ correlations among identified academic mindsets and achievement and identified academic mindsets and achievement in content domains, statistically significant relationships were found. Although, the Pearson $r$ correlations identified statistically significant relationships, mindset effect sizes were small for Value and Like. Meaningful mindset effect sizes of medium to medium-large were found for Confidence. Confidence is important for students to develop as the encounter mathematics and learning in general. The following section of this chapter offers a more detailed explanation of these findings and the degree of their significance.

Analysis and Discussion of the Research Findings

The section presents the analysis and discussion of the research findings. First, the researcher addresses the first research question and its null hypothesis, as well as the implications of the analysis. Following this is a discussion of the second research question and its hypothesis. Also related are the statistical significance of the correlations between identified academic mindsets and achievement and the TIMSS content domains.

Research Question 1

The first research question was: Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade
female standardized mathematics test scores? At $p < .05$, the researcher rejected the null hypothesis addressing identified academic mindsets and achievement based on statistically significant correlations for the sample population of eighth-grade females.

Results of the study show the relationship between academic mindsets of value, like and confident, and mathematics achievement. The higher scores on the mindset questionnaires indicate students having negative thoughts, feelings, and attitudes toward the identified mindset scale. The negative correlations represent low scores on the mindset questionnaires, which indicate more positive growth mindset feelings towards mathematics. It is also important to mention that, although the statistical analysis indicated a significant relationship between academic mindset and overall TIMSS math scores, the researcher determined that effect sizes were small for Value and Like yet medium to medium-large and meaningful for Confidence. The results of student mindsets having a correlation provide a direction for further exploration to enhance and maximize mathematics learning in individual classrooms, schools, school systems, states, and nationally as noted internationally within the TIMSS results.

Research Question 2

The second research question was: Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics? Since $p < .01$, the researcher rejected the $r$-related null hypothesis addressing identified academic mindsets and achievement in relation to content domains
of mathematics based on statistically significant correlations for the sample population of
eighth-grade females.

The correlation between Value mindsets and achievement in the content domain
of Algebra for the sample population was statistically significant at $r(5228) = -0.121, p < .01$. The correlation between Value mindsets and achievement in the content domain of
Data and Chance was statistically significant at $r(5228) = -0.076, p < .01$. The correlation
between Value mindsets and achievement in the content domain of Number was
statistically significant at $r(5228) = -0.087, p < .01$. The correlation between Value
mindsets and achievement in the content domain of Geometry was statistically significant
at $r(5228) = -0.133, p < .01$.

The correlation between Like mindsets and achievement in the content domain of
Algebra for the sample population was statistically significant at $r(5234) = -0.229, p < .01$. The correlation between Like mindsets and achievement in the content domain of Data
and Chance was statistically significant at $r(5234) = -0.136, p < .01$. The correlation
between Like mindsets and achievement in the content domain of Number was
statistically significant at $r(5234) = -0.196, p < .01$. The correlation between Like
mindsets and achievement in the content domain of Geometry was statistically significant
at $r(5234) = -0.184, p < .01$.

Correlation between Confident mindsets and achievement in the content domains
of Algebra for the sample population was statistically significant at $r(5234) = -0.398, p < .01$. Correlation between Confident mindsets and achievement in the content domains of
Data and Chance was statistically significant at $r(5234) = -0.310, p < .01$. Correlation
between Confident mindsets and achievement in the content domains of Number was statistically significant at \( r(5234) = -.380, p < .01 \). Correlation between Confident mindsets and achievement in the content domains of Geometry was statistically significant at \( r(5234) = -.363, p < .01 \).

Conclusions

This study addressed two research questions:

1. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores?

   \( H_01: \) There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores.

2. Is there a statistically significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics?

   \( H_02: \) There is no significant correlation between identified academic mindsets and achievement as measured by eighth-grade female standardized mathematics test scores in relation to content domains of mathematics.

Pearson \( r \) correlations were used to determine the relationship, if any, that exists between identified academic mindsets and mathematics achievement and academic mindsets and achievement in content domains of Algebra, Data and Chance, Number, and Geometry. The relationship between identified academic mindsets and achievement
in content domains of Algebra, Data and Chance, Number, and Geometry was also examined for U.S. eighth-grade females who participated in the TIMSS 2011. With the alpha level set at .05, the null hypotheses were tested and analyzed. This study supports the further exploration of mindset traits and their relationship to mathematics achievement.

However, the results of the statistical analysis of the research questions indicate that although statistical significant relationships exist between the variables under consideration, the effect size of academic mindsets is low in percentage as compared to the effect size of other variables.

Implications

This study contributes to the body of literature regarding academic mindsets, their impact upon learning, and effect on mathematics achievement. Although results from this study found there exist a statistically significant correlation of academic mindsets to mathematical achievement, correlation does not suggest cause and effect. Furthermore, the effect sizes were small for Value and Like, and found medium to medium-large for Confidence, with other variables explaining most of the variance found in TIMSS scores. The small effect sizes outline greater variance exists other than students Value or Like of mathematics. The effect sizes of the Confident mindset scale are larger in the four content domain areas of Algebra, Data and Chance, Number, and Geometry than the other mindsets. Confidence yielded a medium to medium-large effect size and is the most important factor when compared to students’ value or like of mathematics. However, confidence may be a place to start in the classroom. Students can gain this
confidence in many ways to include daily classroom instruction, learning experiences, and fostering of growth mindsets in relation to mathematics and overall academic achievement.

**Recommendations for Future Research**

How do we build students’ value, like and confidence in mathematics? Educators, policy makers, and educational stakeholders should seek to incorporate the teaching and learning of academic mindsets to not only empower students’ beliefs and attitudes, but to also positively impact mathematics learning and achievement. Teachers must seek to share information regarding academic mindsets and foster implementation daily in their classrooms. Future research is necessary to examine correlations and significance of teacher mindsets’ in relation to the mindsets of their students. Whose mindset significantly affects academic achievement: the teachers’, the students’, or both? Similarly, the mindsets of parents and families can play a role in the mindset that the student develops and employs towards learning.

Further research from a qualitative perspective of the role of academic mindsets can potentially gather specific statements and mindsets held by students. As noted in the literature review, research highlights the importance of academic mindsets and their relationship in increasing academic achievement (Boaler, 2013; Dweck, 2006a, 2006b, 2008; Farrington, 2013). Although the results presented on the relationship between academic mindsets and mathematical achievement scores do not provide information about cause and effect, the mindsets establish the stage for effective instruction and learning in the mathematics classrooms.
Results of this study align with the need for educational stakeholders to assist students with strategies that will support their Value, Like, and Confidence in mathematics. Dweck (2015) emphasized the need for students to possess strategies for solving problems when they encounter obstacles, as well as the need for students to have confidence in seeking input from others. For students to learn and improve, they need knowledge of various approaches and strategies. Dweck further expressed that all students currently receive praise, including those putting forth effort but not learning. This praise is given in order to make students feel good. Praise is good for the student expending effort, but it is not good if the student is not learning. Dweck (2015) stated that the growth mindset approach will help students, as they are encouraged to face challenges and view setbacks as paths to learning. However, Dweck expressed her current fear that mindset concepts will become ways to “make students feel good, even if they’re not learning” (p. 20). This study sought to examine academic mindsets of growth as enhancers to learning.

The development of positive mindsets of growth allows the learner to perceive mathematics as presented challenges that can be conquered and solved through resilience and determination versus defeat. Collecting qualitative data regarding student mindsets can possibly give additional insight as to the barriers often found and created in mathematics classrooms for all students. Additionally, the provision of research-based inclusion of academic mindsets in education and proper implementation and best practices will further enhance mathematics classrooms. Students’ negative beliefs and attitudes towards mathematics might lessen. Mathematics classrooms could consist of
teachers and students who view challenges in mathematics as opportunities to grow and as normal pathways to learning and success. Obstacles will not prove to be instant indicators of defeat or failure. Most importantly, the outcome in mathematics will become one of achievement and growth.

Furthermore, it would be valuable to examine mindsets during daily classroom assessments and tasks in addition to standardized testing to determine if, when, and how mindsets change according to specific content. Hattie (2008) contended that most of the powerful effects of schools relate to factors found within schools, “such as climate of the classroom, peer influences, and the lack of disruptive students in the classroom” (p. 18). Hattie’s references of effective contributions from several stakeholders include the student, the home, the school, the teacher, and the curriculum. The researcher further shares insight of expanding the factors that influence learning.

Final Thoughts

Academic mindsets, both fixed and growth, play a role in academic achievement. Barriers often exist in students’ value, like, and confidence in mathematics. The growing STEM careers create a greater emphasis on the necessity to enhance teaching and learning of mathematics, especially for females. In addition to achievement, educators need to be concerned with mindsets that promote or hinder learning. Effective instruction and learning experiences can be created and enhanced as a result of assessing students’ academic mindsets. Educators must teach students to view math as an opportunity and challenge that can be conquered versus the perception as a defeat prior to trying. Teaching students more about growth versus fixed mindsets will give students insight for
paths to obtaining greater academic achievement. The support of policy makers, stakeholders, parents, and teachers to encourage students to value mathematics will thereby increase student confidence and foster views of success in mathematics as attainable for everyone through effort and perseverance.

The challenge remains for educators to continue to assess the academic mindsets of all students, as mindsets certainly have a significant relationship to achievement. Students should develop mindsets similar to the Little Engine That Could, empowering them to recite, “I think I can, I think I can” during mathematics. Policy makers and all education stakeholders should invest in developing and implementing a low-cost focus on mindsets. Mindsets matter, and the duty of educators and advocates includes the teaching of content, but more importantly, equipping students to overcome barriers and strive for success despite the task.
REFERENCES


Kapp, M. B. (2006). Ethical and legal issues in research involving human subjects: Do you want a piece of me? *Journal of Clinical Pathology, 59*(4), 335-


APPENDIX A

PERMISSION TO INCLUDE TIMSS MATERIALS
From: Andrea Netten <a.netten@iea.nl>
Sent: Thursday, March 23, 2017 12:47 PM
To: Catherine Zwaneveld; Leggett, Stephanie
Subject: Re: Request for Permission to use TIMSS data

Dear Stephanie,

Thank you for your request. We hereby grant you permission to use the materials in your dissertation.

I wish you all the best in finalizing your dissertation!

Kind regards,
Andrea Netten
Director of IEA Amsterdam
APPENDIX B

TIMSS SURVEY
Mathematics in School

How much do you agree with these statements about learning mathematics?

Fill one circle for each line.

a) I enjoy learning mathematics  

b) I wish I did not have to study mathematics

c) Mathematics is boring

d) I learn many interesting things in mathematics

e) I like mathematics

f) It is important to do well in mathematics

---

Agree a lot  Agree a little  Disagree a little  Disagree a lot
15

How much do you agree with these statements about your mathematics lessons?

*Fill one circle for each line.*

a) I know what my teacher expects me to do

b) I think of things not related to the lesson

c) My teacher is easy to understand

d) I am interested in what my teacher says

e) My teacher gives me interesting things to do
How much do you agree with these statements about mathematics?

*Fill one circle for each line.*

<table>
<thead>
<tr>
<th></th>
<th>Agree a lot</th>
<th>Agree a little</th>
<th>Disagree a little</th>
<th>Disagree a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I usually do well in mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Mathematics is more difficult for me than for many of my classmates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Mathematics is not one of my strengths</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) I learn things quickly in mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Mathematics makes me confused and nervous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) I am good at working out difficult mathematics problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) My teacher thinks I can do well in mathematics with difficult materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) My teacher tells me I am good at mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Mathematics is harder for me than any other subject</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
How much do you agree with these statements about mathematics?

Fill one circle for each line.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Agree a lot</th>
<th>Agree a little</th>
<th>Disagree a little</th>
<th>Disagree a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>j) I think learning mathematics will help me in my daily life</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k) I need mathematics to learn other school subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l) I need to do well in mathematics to get into the &lt;university&gt; of my choice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m) I need to do well in mathematics to get the job I want</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n) I would like a job that involves using mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

INTERNATIONAL TRENDS IN MATHEMATICS ACHIEVEMENT BY GENDER:

8TH GRADE
Table B1

*International Trends in Mathematics Achievement by Gender: 8th Grade*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>511</td>
<td>499</td>
<td>488</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>507</td>
<td>511</td>
<td>504</td>
<td>509</td>
<td></td>
</tr>
<tr>
<td>Bahrain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td>417</td>
<td>414</td>
<td>431</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>385</td>
<td>382</td>
<td>388</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Botswana (9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>403</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>390</td>
</tr>
<tr>
<td>Chile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td>388</td>
<td>379</td>
<td></td>
<td>409</td>
</tr>
<tr>
<td>Boys</td>
<td>397</td>
<td>394</td>
<td></td>
<td></td>
<td>424</td>
</tr>
<tr>
<td>Chinese Taipei</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>583</td>
<td>589</td>
<td>599</td>
<td>613</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>587</td>
<td>582</td>
<td>598</td>
<td>606</td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td>407</td>
<td>397</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td>406</td>
<td>384</td>
</tr>
<tr>
<td>England</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>495</td>
<td>487</td>
<td>499</td>
<td>511</td>
<td>508</td>
</tr>
<tr>
<td>Boys</td>
<td>500</td>
<td>505</td>
<td>498</td>
<td>516</td>
<td>505</td>
</tr>
<tr>
<td>Georgia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>412</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>430</td>
</tr>
<tr>
<td>Hong Kong SAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>559</td>
<td>583</td>
<td>587</td>
<td>578</td>
<td>588</td>
</tr>
<tr>
<td>Boys</td>
<td>577</td>
<td>581</td>
<td>585</td>
<td>567</td>
<td>583</td>
</tr>
<tr>
<td>Hungary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>527</td>
<td>529</td>
<td>526</td>
<td>517</td>
<td>502</td>
</tr>
<tr>
<td>Boys</td>
<td>527</td>
<td>535</td>
<td>533</td>
<td>517</td>
<td>508</td>
</tr>
<tr>
<td>Iran, Islamic Rep. of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>405</td>
<td>408</td>
<td>417</td>
<td>407</td>
<td>411</td>
</tr>
<tr>
<td>Boys</td>
<td>429</td>
<td>432</td>
<td>408</td>
<td>400</td>
<td>418</td>
</tr>
<tr>
<td>Ireland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>512</td>
<td></td>
<td></td>
<td></td>
<td>520</td>
</tr>
<tr>
<td>Boys</td>
<td>525</td>
<td></td>
<td></td>
<td></td>
<td>512</td>
</tr>
</tbody>
</table>


Table B1 (continued)

<table>
<thead>
<tr>
<th>Country</th>
<th>Girls</th>
<th>Boys</th>
<th>Girls</th>
<th>Boys</th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>475</td>
<td>481</td>
<td>477</td>
<td>493</td>
<td>484</td>
<td>486</td>
</tr>
<tr>
<td>Japan</td>
<td>577</td>
<td>575</td>
<td>569</td>
<td>568</td>
<td>566</td>
<td>574</td>
</tr>
<tr>
<td>Jordan</td>
<td>431</td>
<td>438</td>
<td>438</td>
<td>420</td>
<td>425</td>
<td>411</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td></td>
<td></td>
<td>486</td>
<td></td>
<td></td>
<td>488</td>
</tr>
<tr>
<td>Korea, Rep. of</td>
<td>571</td>
<td>585</td>
<td>586</td>
<td>595</td>
<td>610</td>
<td>616</td>
</tr>
<tr>
<td>Kuwait</td>
<td></td>
<td>364</td>
<td></td>
<td></td>
<td></td>
<td>342</td>
</tr>
<tr>
<td>Lebanon</td>
<td>429</td>
<td>443</td>
<td>444</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>472</td>
<td>480</td>
<td>503</td>
<td>509</td>
<td>507</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>521</td>
<td>512</td>
<td>479</td>
<td>449</td>
<td>517</td>
<td>468</td>
</tr>
<tr>
<td>Malta</td>
<td></td>
<td></td>
<td>488</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morocco</td>
<td></td>
<td>371</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td>497</td>
<td>495</td>
<td>495</td>
<td>478</td>
<td>505</td>
<td>487</td>
</tr>
<tr>
<td>Norway (8)</td>
<td>498</td>
<td>463</td>
<td>471</td>
<td>476</td>
<td>499</td>
<td>467</td>
</tr>
<tr>
<td>Oman</td>
<td>399</td>
<td>397</td>
<td>397</td>
<td></td>
<td>344</td>
<td>334</td>
</tr>
<tr>
<td>Qatar</td>
<td>415</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>404</td>
</tr>
</tbody>
</table>
Table B1 (continued)

<table>
<thead>
<tr>
<th>Country</th>
<th>Girls</th>
<th>Girls</th>
<th>Girls</th>
<th>Girls</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russian Federation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>524</td>
<td>526</td>
<td>510</td>
<td>514</td>
<td>539</td>
</tr>
<tr>
<td>Boys</td>
<td>523</td>
<td>526</td>
<td>507</td>
<td>509</td>
<td>539</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td></td>
<td></td>
<td></td>
<td>401</td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>387</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>610</td>
<td>603</td>
<td>611</td>
<td>600</td>
<td>615</td>
</tr>
<tr>
<td>Boys</td>
<td>608</td>
<td>606</td>
<td>601</td>
<td>586</td>
<td>607</td>
</tr>
<tr>
<td>Slovenia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>492</td>
<td>495</td>
<td>500</td>
<td>502</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>497</td>
<td>491</td>
<td>503</td>
<td>507</td>
<td></td>
</tr>
<tr>
<td>South Africa (9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td>354</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>541</td>
<td>499</td>
<td>493</td>
<td>486</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>539</td>
<td>499</td>
<td>490</td>
<td>482</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>469</td>
<td>453</td>
<td>435</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>465</td>
<td>430</td>
<td>417</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td>457</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td>448</td>
<td></td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td>464</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td>447</td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>490</td>
<td>498</td>
<td>502</td>
<td>507</td>
<td>508</td>
</tr>
<tr>
<td>Boys</td>
<td>495</td>
<td>505</td>
<td>507</td>
<td>510</td>
<td>511</td>
</tr>
</tbody>
</table>