ABSTRACT

An Explanatory Sequential Mixed Methods Study: Solving Mathematics Word Problems Among African American Students

Patrick Hughes, Ed.D.

Mentor: Jessica Meehan, Ed.D.

This explanatory sequential mixed methods study, which consisted of QUAN→ to qual investigated the impact of mathematics word problems among African American students in the seventh grade. This study applied a culturally relevant education (CRE) lens to examine how students solve mathematics word problems. Ladson-Billings (1997) and Gay (2018) established the foundational work of CRE, which emphasizes past experiences, cultural understanding, the frame of reference, and diverse performance styles that students use in solving mathematics word problems.

This investigation focused on student performance on mathematics word problems, attitudes towards mathematics, and the perceptions of mathematics sentences using the Test of Mathematics Abilities, Third Edition (TOMA-3) instrument (V. L. Brown et al., 2013). Data from the TOMA-3 instrument, along with math perceptions subtests and semi-structured interviews, gave an in-depth perspective of student experiences with solving mathematics word problems. The researcher utilized purposive

sampling, with a group of African American students in seventh grade ranging from 13–16 years of age at an urban middle school in southeast Texas.

The researcher discovered significant results based on the performances of the TOMA-3 and the participants' semi-structured interviews. Students scored higher in math computations than mathematics word problems. Students scored higher in the math attitudes section than math computations and mathematics word problems. During the semi-structured interviews, most participants felt confident about their mathematics abilities. The results indicated congruency with high scores in the math attitudes section and confidence in mathematics ability, although the results on the mathematics word problems section of the TOMA-3 were low. The convergence of data also indicated that students experienced difficulty with vocabulary utilized in the mathematics word problem section of the TOMA-3. Student interviews revealed previous experiences with mathematics, limited time, vocabulary, and no learning aids contributed to student frustration with mathematics word problems. The TOMA-3 also revealed that math attitudes among students were above average, although their attitudes towards mathematics word problems differed. There was a non-convergence between student feelings and mathematics scores, indicating that regardless of low or high test scores from the TOMA-3, students felt excitement about the subject of mathematics.

Copyright © 2022 by Patrick Hughes

All rights reserved

An Explanatory Sequential Mixed Methods Study: Solving Mathematics Word Problems Among African American Students

by

Patrick Hughes, B.F.A., M.F.A., M.B.A.

A Dissertation

Approved by the Department of Curriculum and Instruction

___________________________________________

Brooke Blevins, Ph.D., Chairperson

Submitted to the Graduate Faculty of
Baylor University in Partial Fulfillment of the
Requirements for the Degree
of

Doctor of Education

Approved by the Dissertation Committee

___________________________________________

Jessica Meehan, Ed.D., Chairperson

___________________________________________

Sandra Talbert, Ed.D.

___________________________________________

Lacy K. Crocker Papadakis, Ph.D.

Accepted by the Graduate School

May 2022

___________________________________________

J. Larry Lyon, Ph.D., Dean

*Page bearing signatures is kept on file in the Graduate School.*

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AAVE: African American Vernacular English

ASP: After School Programs

CRE: Culturally Relevant Education

ELL: English Language Learners

HELP: Help with English Language Proficiency

LAUSD: Los Angeles Unified School District

NAEP: National Assessment of Education Progress

OECD: Organization for Economic Co-operation and Development

PISA: Program for International Student Assessment

STAAR: State of Texas Assessment of Academic Readiness

TIMSS: Trends in International Mathematics and Science Study

TWI: Two Way Immersion

# ACKNOWLEDGMENTS

I want to express my gratitude to my academic advisor Dr. Jessica Meehan, who has guided me throughout my dissertation. Without her rigorous mentorship, clarity, and encouragement I would not have completed my project. I also wish to acknowledge Dr. Corina Kaul for advising me in developing the quantitative data of the dissertation. She made my dreams come true by helping me develop the mixed methods component, which was impossible on my own. Finally, I would like to thank Kathy Wheeler, the Baylor EdD Writing Center, and the Baylor EdD faculty for supporting me throughout the entire writing process. As a result, I have become a proper research writer and strive to continue to model the rigor that Baylor has instilled in me.

I give thanks to my late mentor, Dr. Warren Debourgeois, who motivated me to go beyond being ordinary. Additionally, I would like to thank my mother, who has always supported me in capturing my goals in life. These two are why I never gave up and could not have achieved the goal of a doctoral degree. Most of all, I want to thank the God Almighty because when I am feeling down, the father comes back to lift me up again. Finally, I want to thank my extended family, friends, and colleagues who supported me during challenging times. Thank You.

DEDICATION

To the African American and mathematics communities who continue to enlighten our youths. I am inspired to help the community believe that mathematics is not just a course in the classroom but a way of life and a magic door to elevating socioeconomic status.

I also dedicate this dissertation to young Black scholars who will utilize my research and expand on it. The African American community must understand that standardized testing does not defy learning. As a community, we utilize ourselves to adapt and overcome barriers to mathematics.

Finally, I dedicate this dissertation to the Baylor EdD department, my colleagues, and my family for your support throughout this journey. You are all the best cheerleaders, especially in the final quarter of the game.

# CHAPTER ONE

## Introduction to the Problem of Practice

### *Introduction*

Mathematics word problems are more than just computations and textbook definitions. Problem-solving is the basis for mathematics word problems, which requires critical thinking. The descriptive language of word problems can be difficult for students as they often do not understand how to fully engage mathematics word problems. Research on mathematics word problems indicates there is a language barrier between the language of word problems and the culture of African American students (A. B. Powell, 2004). Linguistic analogy and breaking down mathematics sentence structures have been critical factors in low mathematics scores across the nation (González, 2015). Part of this issue is due to mathematics programs that utilize computation solving rather than breaking down the language of mathematics word problems, which creates a learning hardship for all age levels (Ladson-Billings, 1997).

According to McCaig (2020), a critical factor in low mathematics scores is the lack of resources such as computers, labs, cultural relevancy, and highly-qualified teachers, which makes it difficult for students to meet educational standards. Most importantly, these resources are lacking in low socioeconomic school districts that have a large African American population. Hollie (2001) emphasized African American students’ home language, “Ebonics,” is translingual and deemed a lousy street language. Anglocentric ideology classifies Ebonics as a form of ignorance or lower education. This perspective creates a prejudice against African Americans (Hollie, 2001). However, Ladson-Billings (1997) argues that Ebonics is a cultural language that is part of the African American community, and educators should incorporate the language within the school curriculum. Ebonics is also referred to African American Vernacular English or Black English, which is spoken in urban communities and the terms are interchangeable with one another (Williams, 1975).

This study examined the language of mathematics word problems and explains the decisions made by students based on their cultural and language experiences when solving mathematics word problems. When working on a mathematics word problem, students decide how to interpret the "situation," which refers to understanding the language within mathematics word problems. This project provides insight to new knowledge on the connection between language and African American math scores.

### *Statement of the Problem*

The 1995 and 1999 Trends in International Mathematics and Science Studies (TIMSS) revealed the United States ranks lower in mathematics compared to other democratic countries around the world (Hiebert et al., 2003). One of the problems is the lack of diversity within mathematics word problems in the United States. Additionally, the instruction of word problems focuses on a high volume of computation procedures with algorithm numerics rather than deciphering mathematics word problems (Hiebert et al., 2003). Based on Shenk and Thompson (2003), African American students with low performances in mathematics understand computation fluency but have difficulties with deconstructing the language of mathematics word problems from Anglocentric text. Sentence structures found in mathematics word problems, which come from an Anglocentric context, excludes the cultural, ethnic, and linguistic needs of African

American students (A. B. Powell, 2004). Achievement in mathematics for minorities in the United States has declined due to standardized testing. Standardized testing requires students to decipher the syntax of written mathematics word problems. Despite efforts such as differentiation and scaffolded lessons, mathematics scores for African American students have decreased over the past 2 decades (Quintana & Mahgoub, 2016). A growing disconnect continues with African American students when encountering the jargon of mathematics word problems.

Linguistics and syntax within the sentence have a significant impact on how African American students respond to readiness standard word problems on the State of Texas Assessments of Academic Readiness (STAAR) test (Fox, 2011; Mejia Colindres, 2015). The mathematics portion of the STAAR test is 65% word problems, where most questions utilize standardized English (Shenk & Thompson, 2003). Anglocentric written word problems for mathematics learning is standard practice for the public-school system in the state of Texas. An Anglocentric focus gives priority to standardized English (Merriam-Webster, n.d.a). Mathematics word problems that derive from an Anglocentric context can be a hurdle for African American students who not only come from a different vernacular speaking household but have difficulty understanding or interpreting mathematics word problems (Gonzáles, 2015). Additionally, Anglocentric mathematics instruction creates learning obstacles for diverse students from low-socioeconomic neighborhoods because of the discontinuity of the quality of mathematics (Ladson-Billings, 1997).

Standardized testing creates a classroom environment of checklists, rather than spending time comprehending mathematics word problems. When students read word problems, the “situation” or mathematics terminology found in these word problems can make it difficult for students to construct numerical outputs (Mattarella-Micke & Beilock, 2010). For example, if a mathematics word problem contains multi-meaning words such as “table,” then “furniture” or “chart” are two possible interpretations. Another example is when asked to find the “sum,” students might understand the term as “some.” Likewise, the same might happen when using other homophones such as “whole” or “hole.” Another example is understanding the rules that govern a mathematics sentence where syntax can be confusing. The mathematics sentence “A number y is 6 more than the number x,” translates to $y = x + 6$. The “situation” can be confusing if students do not recognize the mathematics jargon or syntax found in mathematics word problems.

Different meanings within the context of a word problem can confuse diverse students who are not familiar with the syntax or semantics used in the problem. When students encounter homonyms where the words have the same spelling but different meanings, the framework can confuse students when deciphering the correct definition. For example, when students from a low-socioeconomic environment encounter the phrase “Finding the product of 68 and 10,” some adolescents do not make the connection with “multiplication” and “product.” Some adolescents may identify “product” with food or items because they are not familiar with the context of the term as applied in mathematics word problems. Another example is when interpreting a mathematics sentence such as, “Steve bought four bags of rice with 2 pounds of rice in each bag. How many pounds of rice did Steve buy?” This mathematics word problem uses both past and present tense of the irregular verb “buy.” Students identify past tense verbs ending in “ed” and may not be familiar with irregular verbs. Mathematics is not just a procedural method but a conceptual method that comes from real-world connections and requires syntactic and sematic knowledge for understanding mathematics word problems.

Test scores show a gap between diverse groups and White students. Many diverse groups such as African Americans experience opportunity gaps, which result in lower test scores than White students. STAAR mathematics scores for African American students in the seventh grade are 50% below their White counterparts in the state of Texas (Texas Education Agency, 2019). A possible reason for low-performance scores in mathematics is the linguistic misalignment between the student's home language and the language utilized in the classroom curriculum or in the school culture. The researcher investigated the language of mathematics word problems found in the TOMA-3 (V. L. Brown et al., 2013) instrument and the learning outcomes for African American students in the state of Texas.

## *Purpose of the Study*

The purpose of this explanatory sequential mixed-method study, which is QUAN→qual, was to explain African American students' perceptions of the linguistic jargon applied in mathematics word problems found on the TOMA-3 (V. L. Brown et al., 2013). This explanatory sequential mixed methods study provides insight into how African American students interpret mathematics word problems and the difficulties they encounter with standardized English. The researcher also details the relationship between the language spoken in the African American household, "Ebonics," and codeswitching to standardized English when solving mathematics word problems. Data from the TOMA-3 aided in the development of semi-structured interviews. Additionally, data from the TOMA-3 instrument assisted in the selection of participants for semi-structured interviews.

The researcher also sought to determine if African American students score lower in the mathematics word problems category than the computations category on the TOMA-3 (V. L. Brown et al., 2013). Additionally, the researcher wanted to explain the results of the TOMA-3 assessment as it relates to mathematics language, syntax, and vocabulary found in word problems. With this explanatory sequential mixed methods study, the researcher’s goal was to address the following research questions:

1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance?
2. What contributed to African American middle school students’ performance between math computations in comparison to word problems?
3. How do the themes that emerged from the interview with African American middle school students explain the quantitative math attitude, computation, and word problem scores?

While previous studies have recognized the phenomenon of low mathematics scores within the African American community, this research strived to understand the cultural barriers between home language and standardized English text found in mathematics word problems. The literature does not cover the linguistic aspects of mathematics learning with African American students as the curriculum caters to White middle-class households (American United for Separation of Church and State, 2014; Gewertz, 2015; Strauss, 2014). The researcher, motivated by this argument and the literature gap, sought to explore the language issues by examining African American student approaches to solving mathematics word problems.

## *Theoretical Framework*

The researcher utilized the culturally relevant education (CRE) theoretical framework that centralizes around learners whose culture and real-world experiences do not align with the Anglocentric perspectives of the public school system. Ladson-Billings (1997) and Gay (2018) designed the conceptual framework that focuses on how instruction helps adolescents from diverse backgrounds (B. A. Brown et al., 2019). Gay (2018) emphasizes the inclusion of reference, past experiences, cultural knowledge, and learning styles for diverse students. CRE incorporates constructive changes on several learning levels, such as instructional materials, classroom climate, instructional techniques, student-teacher relationships, and self-awareness to improve student learning (B. A. Brown et al., 2019; Ladson-Billings, 1997).

African American students require asset-based approaches that reflect their culture, language, and identities within the curriculum. Curriculum and assessments written from an Anglocentric perspective of learning create learning barriers for diverse groups. When exploring African American students' culture, educators should explore the linguistic language spoken in the household and utilize that language within classroom lessons. By connecting through Ebonics and the African American culture, educators can bridge the gap in the comprehension of mathematics word problems.

## *Research Design*

The researcher applied an explanatory sequential mixed methods design, QUAN→qual. The researcher implemented two strands where the quantitative method came first followed by the qualitative method to explain the quantitative results. This explanatory sequential mixed methods design draws on the strength of quantitative and qualitative research, which minimizes both approaches' limitations. The first phase involved 34 participants for the quantitative method and then utilized the qualitative methods in the second stage with in-depth interviews with four participants. The quantitative phase applied V. L. Brown et al.'s (2013) TOMA-3 instrument to determine if African American students perform differently in math computations and word problems. Additionally, the TOMA-3 assessed student attitudes towards mathematics. The qualitative phase included semi-structured interviews to explain the qualitative results with special attention to how language may contribute to student understanding of mathematics word problems.

### *Definition of Key Terms*

*African American Vernacular English:* A paralinguistic and linguistic component of language that concentric continuum represents the oral competency of Caribbean, West African, and United States slaves who are decedents of African origin (Williams, 1975).

*Anglocentric:* Defined as giving priority or centering on things that are standardized English (Merriam-Webster, n.d.a).

*Culturally Relevant Education:* A method used to empower students socially, emotionally, intellectually, and politically by incorporating cultural referents to communicate the attitudes, skills and knowledge of other cultures during instruction (Ladson-Billings, 1997; Gay 2018).

*Ebonics*: A combination of the word "ebony" and "phonics," which is a fluid linguistic dialog or subsystem of the English language that is spoken by African Americans (Foy-Watson, 2010).

*Ethnolinguistics*: A branch of linguistics that focuses on language concerning ethnic types and behavior (Crystal, 2008).

*Ethnomathematics*: Literature that pertains to relationships between culture and mathematics with multicultural ideas in the school curriculum (Barton, 1996).

*Homonyms*: where the words have the same spelling, but different meaning (Merriam-Webster, n.d.b).

*Homophones*: One or two words that sound the same but have a different spelling or meaning (Merriam-Webster, n.d.c).

*Linguistic analogies*: Generative linguistics and transformational grammar that explains the productive formation of structures such as phrases within word problems (Lagasse, 2018).

*Situation*: This is a reference to a student solving a mathematics word problem or breaking down the linguistics (Mattarella-Micke & Beilock, 2010).

*STAAR test:* Standardized test that determines a student's learning level (Texas Education Agency, 2019).

*Trends in International Mathematics and Science Studies*: TIMSS provides substantial data that is on mathematics and science trends from 60 countries around the world (National Center for Education Statistics, 2019).

## *Conclusion*

The researcher examined the experiences that students have with mathematics word problems, how the student participants interpret the jargon within mathematics sentence structures, and how the student participants' language differs from academia. Through testing with the TOMA-3 instrument, math perceptions subtests, and semi-structured interviews, the researcher explored how language and mathematics sentence structure impact students inside the classroom. Chapter Two presents a review of the literature detailing the academic achievement gap, opportunity gap, mathematics word problems, Anglocentric text, Ebonics, and why CRE practices with mathematics word problems can benefit African American students.

# CHAPTER TWO

## Literature Review

### *Introduction*

In this explanatory sequential mixed methods study, the researcher argues that the Anglocentric context of mathematics word problems is harmful to African American students whose home language differs from the mathematics jargon within the school curriculum. The language of mathematics applies standardized English and does not permit the ethnolinguistic distinctions of Ebonics or other subsystem languages (S. E. Anderson, 1990). According to Ashcroft (1994), most African societies are built around oral culture as the language is different from the western tradition. Understanding how the Anglocentric text could serve as a language barrier for African American students with low-performance scores in mathematics is vital to their academic growth.

This chapter uncovers the academic achievement gap between African American students and White students in terms of standardized testing. Additionally, in Chapter Two, the researcher discusses the opportunity gaps that hinder African American adolescents from striving to their full potential. This chapter also highlights the home language of African American students and explains how Ebonics does not align with the Anglocentric text in mathematics word problems. The chapter shares how policymakers contribute to the Anglocentric writings found in textbooks and word problems. Chapter Two explains mathematics word problems such as grammar, wording, and sentence structures. The chapter concludes by highlighting the limited studies on the issues with mathematics word problems and how the researcher sought to address the gap in the literature.

### *Academic Achievement in Mathematics*

There is an issue with low math scores in the United States compared to England, Singapore, Sweden, and other top-ranking countries. According to Barshay (2019), the first international comparison in 1967 ranked the United States 11 out of 12 nations. Students from France, Japan, Germany, and England scored higher in mathematics than students in the United States. Today, the Programme for International Student Assessment (PISA) results for mathematics indicate the United States still ranks below the same countries from the 1967 comparison (Organization for Economic Co-operation and Development, 2019). According to OECD (2019), the United States is ranked 36th out of 79 countries, which is a tremendous drop since the first international comparison. The United States results in mathematics have fallen in the past 3–9 years (Johnson, 2016). TIMSS indicates mathematics in the United States ranks low among other diplomatic countries, which corresponds to the data from PISA (Hiebert et al., 2003).

Reports from the National Assessment of Educational Progress (NAEP) indicate significant drops in math scores in 2019, which are parallel to the PISA and TIMSS reports (Camera, 2019). For subgroups such as African American students, scores are significantly lower than White students on a national level. The African American population performs the weakest in mathematics among other subgroups. Based on NAEP scores, African American students in the fourth grade for 2019 (Table 1) scored 27% lower than White students in mathematics. Scores on the Nation's Report Card

(NAEP) for African American students in the eighth grade for 2019 (Table 2) shows African American students scored 28% lower than White students in mathematics.

Table 1

*Fourth Grade Mathematics Performances for Reporting Groups (NAEP)–2019*

| | | | % at or above NAEP | | % at NAEP |
|---|---|---|---|---|---|
| Reporting Groups | % of Students | Avg. Score | Basic | Proficient | Advanced |
| Race/Ethnicity | | | | | |
| White | 27 | 232 | 78 | 48 | 12 |
| Black | 10 | 205 | 48 | 16 | 2 |
| Hispanic | 55 | 208 | 52 | 21 | 3 |
| Asian | 5 | 247 | 89 | 65 | 25 |
| American Indian/Alaska Native | # | ‡ | ‡ | ‡ | ‡ |
| Native Hawaiian/Pacific Islander | # | ‡ | ‡ | ‡ | ‡ |
| Two or More Races | 2 | 225 | 74 | 38 | 6 |
| Gender | | | | | |
| Male | 51 | 212 | 58 | 27 | 6 |
| Female | 49 | 220 | 65 | 34 | 8 |
| National School Lunch Program | | | | | |
| Eligible | 61 | 206 | 50 | 19 | 3 |
| Not Eligible | 39 | 232 | 79 | 48 | 13 |

*Note*. Adapted from See How U.S. Fourth-and Eighth-Grade Students Performed in Mathematics, 2019, The Nation's Report Card. (www.nationsreportcard.gov/about.aspx)

Table 2

*Eighth Grade Mathematics Performances for Reporting Groups (NAEP)–2019*

| Reporting Groups | % of Students | Avg. Score | % at or above NAEP Basic | % at or above NAEP Proficient | % at NAEP Advanced |
|---|---|---|---|---|---|
| Race/Ethnicity | | | | | |
| White | 28 | 293 | 80 | 44 | 13 |
| Black | 11 | 265 | 52 | 16 | 2 |
| Hispanic | 53 | 272 | 63 | 21 | 3 |
| Asian | 5 | 318 | 90 | 71 | 36 |
| American Indian/Alaska Native | # | ‡ | ‡ | ‡ | ‡ |
| Native Hawaiian/Pacific Islander | # | ‡ | ‡ | ‡ | ‡ |
| Two or More Races | 2 | 287 | 75 | 41 | 11 |
| Gender | | | | | |
| Male | 51 | 279 | 67 | 29 | 8 |
| Female | 49 | 280 | 69 | 30 | 7 |
| National School Lunch Program | | | | | |
| Eligible | 58 | 270 | 59 | 19 | 2 |
| Not Eligible | 39 | 293 | 80 | 45 | 14 |

*Note*. Adapted from See How U.S. Fourth-and Eighth-Grade Students Performed in Mathematics, 2019, The Nation's Report Card. (www.nationsreportcard.gov/about.aspx)

When observing the mathematics scores of the Texas STAAR test, the ratings for African American students not only align with NAEP reports but indicate these students are scoring lower than the national reports. According to the Texas Education Agency

(2019), policy requires students from third grade to 11th grade to take the STAAR mathematics test. Students must meet the standards of both supporting and readiness standards. Roughly around 65% of the STAAR mathematics test consists of readiness Texas Essential Knowledge and Skills, which consists of mathematics word problems that require students to solve the “situation” by interpreting the mathematics jargon (Bailey, 2018; Jones, 2017). Minorities from Grades 6–8 that come from low socioeconomic neighborhoods are still performing below academic standards (A. B. Powell, 2004). Based on the STAAR mathematics results from 2019 (Table 3), African American students in grades sixth through eighth reached a score of 33% for meeting the state standards while White students averaged 59% in reaching the state standards (Texas Education Agency, 2019).

Based on the data from Table 3, African American scores are below 50% in meeting the state standards compared to their non-minority counterparts. Based on the STAAR mathematics results from 2019, White students in Grades 6–8 accumulated around 60% for meeting state standards (Texas Education Agency, 2019). Less than 20% of White students did not meet the standards compared to African American students, where more than 20% did not meet the standards (Texas Education Agency, 2019). Scores from the STAAR mathematics test indicate White students outperform African American students. Data suggest White students are more prone to speaking in standardized English, which parallels the school curriculum (Harper et al., 1998). The achievement gap may originate from standard proficiency levels or from a cultural upbringing that does not align with Anglocentric text (William, 1997).

Table 3

*Mathematics Performances for Reporting Groups–STAAR 3-8, State, Spring 2019*

| | | | | STAAR – Mathematics | | | |
|---|---|---|---|---|---|---|---|
| | | | | Did Not Meet | Approaches | Meets | Masters |
| Group | Grade | No. Tested | Avg. Scale Score | % | % | % | % |
| State | 6 | 389219 | 1646 | 21 | 79 | 45 | 20 |
| Hispanic/Latino | 6 | 213838 | 1623 | 24 | 76 | 38 | 14 |
| Asian | 6 | 16025 | 1810 | 4 | 96 | 83 | 61 |
| Black or AA | 6 | 51269 | 1598 | 31 | 69 | 31 | 11 |
| White | 6 | 108087 | 1691 | 12 | 88 | 59 | 29 |
| State | 7 | 343110 | 1659 | 27 | 73 | 40 | 15 |
| Hispanic/Latino | 7 | 191668 | 1640 | 30 | 70 | 35 | 11 |
| Asian | 7 | 13328 | 1825 | 7 | 93 | 79 | 55 |
| Black or AA | 7 | 46312 | 1610 | 40 | 60 | 54 | 22 |
| White | 7 | 91802 | 1700 | 17 | 83 | 54 | 22 |
| State | 8 | 328161 | 1712 | 19 | 81 | 55 | 16 |
| Hispanic/Latino | 8 | 179360 | 1693 | 21 | 79 | 50 | 12 |
| Asian | 8 | 12497 | 1863 | 4 | 96 | 86 | 53 |
| Black or AA | 8 | 45096 | 1664 | 28 | 72 | 41 | 8 |
| White | 8 | 91208 | 1752 | 12 | 88 | 67 | 24 |

*Note*. AA = African American. Adapted from *Group summary performance levels for STAAR 3-8, State, Spring 2019*, Data Interaction for Texas Student Assessment, 2021. (https://txreports.emetric.net/)

In conclusion, specific subgroups have differentiated needs that correspond with their cultural needs, such as the spoken language and the written text. The STAAR mathematics assessment speaks its own jargon rooted in standardized English and is not inclusive of diverse language speakers whose dialect is different (Gowers et al., 2008). Research suggests linguistic analogy and the restructuring of mathematics sentences are required during lessons, regardless of the teaching model in place (Bailey, 2018). Data indicates huge language gaps between minority and middle-class homes as White students have an advantage as the school curriculum caters more to the Anglocentric household culture.

### *Opportunity Gaps*

When examining the achievement gap between African Americans and other subgroups, African American students rank the lowest in mathematics scores. The data gap between White students and African American students is a 20% difference in the state of Texas (Data Interaction for Texas Student Assessment, 2021). The achievement gap indicates there are underlying factors, which have created adversity for African American students who aspire to reach success in mathematics (Flores, 2018; Rubin et al., 2016; The Kentucky Advisory Committee, 2007). Some of the factors include: households without computers or Wi-Fi connection, a lack of technology integration during instructional time, inexperienced or unqualified teachers, non-cultural-relevant curriculum, educators that do not recognize the culture or ethnic background of students, students that live in low poverty neighborhoods, and a lack of enrichment opportunities.

When highlighting aspects of the opportunity gap, one particular factor is the household structure of African American children. Children raised in middle-class households develop traits that differ from those traits that might develop in a low-socioeconomic household. Middle-class households have parents with careers or working jobs where decisions are made collaboratively. Career-working parents can alter their career choices within the workplace. Children from middle-class households begin to take on these traits, which motivates them to connect with other students and make academic decisions (Gorski, 2018; Rothstein, 2004). On the other hand, low-socioeconomic parents work jobs where they are given more directives and instructions rather than decision-making opportunities. Children from low-socioeconomic households lack opportunities to develop motivational traits and decision-making skills typically found in a middle-class household (Gorski, 2018; Rothstein, 2004). Additionally, due to a lack of income, African American children in low-socioeconomic households lack academic enrichment opportunities provided by their parents, which creates a gap for potential growth.

Another opportunity gap that hinders African American students lies within the public school system. The African American population has a massive dropout rate due to high disciplinary actions by teachers and administrators (Schwerdt & West, 2013). Many negative stereotypes for Black students are described as "uneducated," "out-of-control," and "dangerous" (Bryant, 2017; Gorski, 2018; Maylor, 2014). Negative stereotypes can lead to a lack of engagement inside the classroom and generate negative behavior. Most of the teachers that come from middle-class communities speak standard English during classroom instruction (Crystal, 2008). P. J. Anderson (1999) explained that most teachers have little understanding of the Black language and are most likely to have negative feelings about Ebonics due to misalignment of literacy skills with school achievement and sociopolitical location. However, cultural relevant pedagogy training with teachers can develop strategies for building rich curriculums and develop students in reaching their highest potential. Gorski (2018) explained a strong relationship between teachers and Black parents can eliminate negative attitudes by understanding the culture of African American households.

An additional opportunity gap these students experience is the lack of quality instructors. On average, middle school teachers have an average of 12.5 years of experience (National Center for Education Statistics, 2020). In contrast, teachers with the least amount of experience are being hired in low socioeconomic school zones (Stein, 2012). The teacher turnover rates in the public school system are about 66% due to lower pay, teacher training, support, and conditions that teachers endure (Carver-Thomas & Darling Hammond, 2017). Teacher shortages exist in the areas of mathematics, special education, science, foreign, and English language development (Carver-Thomas & Darling Hammond, 2017; Gorski 2018). Many new teachers that districts hire have little to no experience or are underqualified, which has an impact on academic achievement.

Despite having a distinct home language, African American students who speak Ebonics are not afforded the same language program opportunities as English language learners (ELLs). ELLs have access to dual-language and two-way immersion (TWI) programs in the United States. Most dual-language and TWI programs are in the state of California (California Center of Applied Linguistics, 2016). Researchers identified that the dual-language and TWI programs around the country assisted ELLs in becoming proficient in English as their native English-speaking peers (Folsom, 2016; Piedra et al., 2018; Rodriguez et al., 2014). Most public schools do not have a dual language or a TWI program, which has the potential to help eliminate the language gap with students whose first language is not standardized English. However, it is important to note the dual-language and TWI programs do not support the language of Ebonics, which excludes the African American population.

Even with online mathematics programs, the exclusion of African American vernacular hinders the opportunity for academic growth, which serves as another opportunity gap. These online language programs help support the learning of mathematics. The U.S. Department of Education and Ready to Teach grants funded the "Help with English Language Proficiency" (HELP) program (Crawford, 2013; Freeman & Crawford, 2008). HELP is online instruction for second language learners but is especially suited for Spanish-speaking students because of the side-by-side Spanish aid system. Mathematics is a technical language and can prove difficult for foreign language speakers. The technical language can include terms such as product and value scale, or symbols such as < greater than or filling in the variables. HELP is mainstreamed to help teachers who train to teach ELL students. Students showed a 42% increase when utilizing this program over time, whether they were a beginner, intermediate, advanced, or special ed student (Crawford, 2013; Freeman & Crawford, 2008). HELP is an online program the district or individual families can purchase as a way to close the achievement gap for non-native-speaking students (Boulder Learning, 2013). HELP does not include an Ebonics software suite for African American students. African American students continue to struggle with technical mathematics language and with the standard English language.

The goal for after school programs (ASPs) is to motivate culturally relevant pedagogy, which encourages the youth to interact with the adult community leaders in both ethnic and racial conversations. Youths begin to admire their own ethnic, racial, and cultural identities as a sense of empowerment (Gao, 2017). ASPs play a role in academic tutoring, mentorship, substance abuse, art, sports, employment opportunities, and neighborhood watch activities. Most funders distribute money to programs that only deal with high-stakes testing and accountability, which can make it hard to utilize culturally relevant pedagogy in ASPs (Gao, 2017). Despite initiatives intended to combat the opportunity gap like After School Programs, ASPs lack the alignment of the academic curriculum, which marginalizes Ebonics as a subgroup language of standard English and not as its unified language. ASPs lack staff training, resources, and strategies that align with dual-language programs. Even funding with ASP's can create adversity without school affiliation as youths who are from low-socioeconomic households continue to fall short of academic success.

In conclusion, African American students face a variety of opportunity gaps that prevent these students from reaching their academic potential. Household structures are the essence of a child's development. African American children raised in a low-socioeconomic home are often at a disadvantage. Many teachers serving these students are not qualified for teaching minority students as there is a disconnect between the teacher's and the student's culture. Content specialists such as math teachers are scarce in the public school system. The language gap initiatives only address ELLs through dual language, TWI programs, and HELP. Ebonics or African American Vernacular English (AAVE) has no support from the school curriculum as a trans-language dialect, which does not allow Black students to close the achievement gap. Although there are ASPs that support community culture outside of school, African American students have no support programs for in-school language or mathematics programs.

### *Policy Makers and Textbooks*

The conservative right controls the textbook selection in the State of Texas (Hefley, 1979; Merrow, 1982; Thevenot, 2010). The conservative right bans certain books based on political ideals or text that seem ungodly (Hefley, 1980; Merrow, 1982; Thevenot, 2010). Textbook selection dates back to the 1960s, when Mel Gabler and his wife started the conservative movement for textbook selection. Mel Gabler and his wife debated with the Texas State Board of Education committee on numerous occasions about modifications with specific material in school textbooks. The debates won over the Texas State Board of Education committee as supporters helped shape the conservative ideologies within the Texas education system (Hefley, 1980; Merrow, 1982; Thevenot, 2010). Many conservative ideologies have created a culture of Anglocentric texts, which does not align with native Ebonics speakers or foreign language learners. Overtime, Anglocentric text has overshadowed the ideas and history of other indigenous cultures that have played a role and are contributors to this body of knowledge (S. E. Anderson, 1990; Bruno & Baker, 1999; Gardner, 2001; Merzbach & Boyer, 2010). When there is mention of other scholarly authors in history textbooks who are African American, Chinese, Indian, and Mayan, they are only in footnotes or small paragraphs, making the minority diminutive within the text (S. E. Anderson, 1990; Bruno & Baker, 1999).

Even in the present time, Anglocentric perspectives dominate the textbook industry within the United States. The struggle for intellectual power lies with race, gender, class, and religious views. The conquest for power in how education shapes children continues to manifest from Anglocentric ideologies that exclude women, people of color, and others from having their history included inside the textbooks (Apple, 1990). For years, the Texas State Board of Education monopolized the textbook choices in education. Although there were changes over the years with common core and technology, the Texas State Board of Education is still the dominant voice overall. The board consists of 15 members who are responsible for selecting all the textbooks that the school districts will use during the school year (Americans United for Separation of Church and State, 2014; Gewertz, 2015; Strauss, 2014). District officials, administrators, teachers, parents, and students do not have any voting power over what textbooks or materials the board chooses. Social conservatives control the board with Anglocentric perspectives that undermine other cultural narratives (Americans United for Separation of Church and State, 2014; Gewertz, 2015; Strauss, 2014). Even though the board makes the final decision, external panels assist the board as consultants. Many panelists lack academic experience in public education, yet they influence the textbook choices.

The demographics within the Texas State Board of Education is 13% African American, 20% Latino, and 67% White (Texas Education Agency, 2020a). However, conservative ideologies dominate the Texas state standards and textbooks. Even with subjects such as social studies, the board approved 100 amendments that had conservative and political agendas (Riley, 2012). For example, conservative members during this time frowned upon Thomas Jefferson’s quote, “separation of the church and state” (Riley, 2012, para. 2). The Texas State Board of Education removed Thomas Jefferson from the list of Enlightenment in 2010 (Riley, 2012). The board brought back

Thomas Jefferson but excluded the “Enlightenment” as separation of church and state is not the central point of the first amendment. The Texas State Board of Education continues rewriting history based on the conservative viewpoints that impose on facts.

The Texas State Board of Education adopts textbooks about every eight years and only view 25% of the text (Hewlett, 1988; McGaughy, 2014; Scudella, 2013, Texas Education Agency, 2020a). Textbooks that the Texas State Board of Education deem appropriate are in adoption for 8 years or more. There are about 4.8 million textbooks that the Texas State Board of Education review each year (Riley, 2012). When voting for statewide distribution, the board chooses a conforming or a non-conforming list to determine what is best for school districts. School districts report to the board on whether they adopt conforming or non-conforming textbooks for their school’s curriculum (Hewlett, 1988; McGaughy, 2014; Scudella, 2013; Texas Education Agency, 2020a). The board, along with other panelists, educators, and stakeholders, adopt curriculum standards that correspond with textbook selections, which Texas refers to as the Texas Essential Knowledge and Skills.

Research findings show most of the board members have conservative views, regardless of ethnic backgrounds (Timsit & Merelli, 2018). For example, a textbook adopted by the Texas State Board of Education, the *Prentice Hall Classics: A History of The United States*, depicts the history of slavery as “exaggerated” as some slaves were happy (Timsit & Merelli, 2018). The textbook implied that even though the plantation owners beat the slaves, they treated some slaves relatively well, which was a misrepresentation of the history of slavery in America. Even with revolutionary films, most ideologies came from U.S. history books dating from the 1800s to the early 1980s which derived from the Jim Crow and the Civil War Reconstructionist period (Yacovone, 2018). Revolutionary films such as “The Birth of a Nation,” depicted the Ku Klux Klan as warriors and people of color as villains during the Civil War (Griffith, 1915; Lehr, 2014). The film depicted people of color as wicked and evil. The White actors colored their faces black to depict the wrongful images of African American characters, which had a confederate perspective. At the time of the “Birth of a Nation” debut in 1915, history books were parallel to the film’s ideology and was a misrepresentation of history (Griffith, 1915; Lehr, 2014). Many people believed the conservative ideologies found in the textbooks and scholarly articles of that time period.

Educators taught topics such as the Civil War, reconstruction, slavery, race, and abolition from the early 1800s to the 1960s from the perspective of White conservatives (Klein, 1985; Rebolini, 2017; Yacovone, 2018). Writings of anti-slavery and the evolution of the Civil War movement are in the old American textbooks. Some of the books titled as *The White Man’s History* and *Dear White America* where African Americans are portrayed as “ignorant slaves” who caused problems for White Americans (Klein, 1985; Rebolini, 2017; Yacovone, 2018). The influence of White conservatives has impacted the course of history, which streamlined into the school textbooks and other scholarly texts. White conservative ideology is a constitutive element that is mainstream in American textbooks, movies, and advertisements. Then the AAVE language system of the 1970s was put in place to help Black children with connecting their household language with the learning of standardized English. When the research became public, many conservative parents and policymakers argued that Ebonics, which is also referred to African American Vernacular English would destabilize standardized English.

Policymakers and conservative parents expressed that using phrases such as "We be going there," would make it difficult for students to apply for jobs in the future or with writing papers in college (Hobbes, 2017, para. 4).

The same individuals who argue against AAVE are the ones who push the board to make conservative decisions. The same board selects the mathematics textbook and curriculum standards for the State of Texas. The board views any non-conforming textbook as futile. Standardized English is the dominating text in the State of Texas. Until the State Board of Education changes their political views, African Americans and other cultures will never have an opportunity to shape the narrative of the mathematics curriculum.

### *Mathematics Strategies for Solving Word Problems*

The basic operations of multiplying, subtracting, adding, and dividing are the foundations for solving mathematics computations. To solve mathematics word problems, students must understand computations in operations, how to use the right formula, and effectively use strategies when solving word problems (Kikas et al., 2019; Tran et al., 2011; Zhang & Xin, 2012).

In addition to using strategies, students must use cognition and memory. Swanson's (2013) research outlines whether strategies for focusing on keywords would improve mathematics skills for students with math difficulties and working memory capacity. During the research, Treatment 1 focused on children recalling the word problems that they read and then solving the word problem with the correct algorithm. Treatment 2 focused on the numerical aspects of the word problem and then solving the word problem with the correct algorithm. Ninety-one third graders participated in the research for problem solving (Swanson, 2013). The strategies used in both treatment groups improved student posttest scores. The demands for memorizing strategies were higher for children with math difficulties. Memorization is a significant part of solving mathematic word problems and utilizing formulas for equations (Kikas et al., 2019; Tran et al., 2011; Zhang 2011).

Research indicates active learning strategies are the key to solving math problems, which involves cognitive thinking (Kikas et al., 2019; Tran et al., 2011; Zhang 2011). Kikas et al. (2019) conducted a study about middle school students on solving mathematics equations and word problems using comprehension learning styles. Comprehension learning styles include task persistent learning behavior, reasoning abilities, math self-concept, and reading comprehension. The researchers uncovered that calculation skills alone did not improve mathematics scores, but reading comprehension, task persistence, and math self-concepts made a vast difference (Kikas et al., 2019). Comprehension support improves the metacognition in solving mathematics word problems (Jitendra et al., 1999; Krawec et al., 2013; Stone & Atta, 2007).

Other effective strategies for solving word problems are the use of learning aids. Learning aids have various categories such as pictorial diagrams, written language, action movements, oral language, and mental images, which are guides to cognitive problem solving. Diagrams are a powerful component to solving mathematics word problems, although poor diagram pictorials are difficult to interpret. Van Garderen et al. (2013) tested students with learning disabilities on whether schematic or pictorial diagrams made a difference in solving mathematics word problems. Grades 4–7 test results concluded that most students preferred schematic diagrams (Van Garderen, 2006, 2007; Van

Garderen et al., 2013). Students with learning disabilities relied heavily on pictorial diagrams, due to complicated schematic diagrams. Diagrams are an essential asset to solving mathematics word problems, depending on the students' preferences of diagrams.

Although there are various strategies for solving mathematics word problems, students who are ELLs need additional support for language and reading comprehension (Kim, 2011; Guglielmi, 2012; Orosco, 2014; Orosco et al., 2011). Based on Orosco et al. (2011), the Dynamic Strategic Math program is a strategic method that Latino ELLs who are at-risk use as an aid. The program includes three levels based on pre-taught math skills, comprehension strategy, and the collaborative approach. The Dynamic Strategic Math strategy provides continuous feedback on language and reading comprehension levels, which is an intervention method for improving problem solving skills in math word problems. Overall, Dynamic Strategic Math improved mathematics abilities with ELLs (Orosco et al., 2011). Intervention with language and reading comprehension can close the achievement gap for second language learners in mathematics.

Strategies for solving mathematics word problems can vary from rote memorization, cognitive thinking, and diagrams. Even for ELLs, reading comprehension and language components support the mathematics strategies inside the classroom. Unfortunately, the research lacks mathematics strategies with AAVE or with African American students in general. English language support is not exclusive for native speakers but trans-language speakers of the English language.

### *Language Support for Math Word Problems*

When solving mathematics word problems, students must understand the missing variables and decode the text to configure the word problem into a solvable formula

(Kikas et al., 2019). The text of the word problems is the essential aspect of mathematics word problems (Kikas et al., 2019; Tan, 1998). Most native English students solve problems using math procedures and calculations, where ELLs need additional reading comprehension and linguistic support (Kim, 2011; Guglielmi, 2012; Orosco, 2014; Orosco et al., 2011).

African American students who speak Ebonics often encounter language that can serve as an obstacle. These obstacles occur when trying to decipher the syntax of mathematics word problems, where standardized English becomes a barrier for learning. Standardized English in mathematics textbooks and word problems require understanding or comprehending specific phrases or words in the English text (Hawkins, 2014). Solving mathematics word problems involves processes and procedures that aid in the breakdown of the "situation" to basic computation (Cawley et al., 1979). The analysis in the breakdown of mathematics word problems involves the understanding of synonyms, homophones, vocabulary, conjunctions, and sentence structures.

When deciphering synonyms and vocabulary in STAAR mathematics word problems, African American students have difficulty understanding and comprehending (S. Powell et al., 2019). For example, the sentence "A cylindrical barrel has a diameter of 19.875 inches, which of the following is the best estimate of the barrel's circumference in feet?" (Texas Education Agency, 2019, p. 6). The word "cylindrical barrel" may be confusing for someone who has never used a barrel or may not know that this is just another cylinder shape. According to Edens and Potter (2008), a picture would help some students who might call this word a "drum" or "beer cask" (p. 184). Another example word problem that can confuse students is, "A farmer has a bale of hay with a mass of 36 kilograms, how many milligrams of hay is in the bale?" (Texas Education Agency, 2019, p. 10). Students might see the word "bale" and might not know that the word identifies with "bundle," "pile," or "stack." Visuals would be necessary for the student who uses subsystem languages within their household and not the standard Anglocentric descriptors found in mathematics word problems (Hawkins, 2014).

Vocabulary terminologies in mathematics word problems can share similar meanings, but different spellings. In terms of math vocabulary, "quotient" means "answer for division," where add, plus, and combine have the same meaning, but students might not understand high-descriptor synonyms. "Quotient" and "combine" are content specific words, which can be foreign to a student who does not use the terms often in their household. There are also multi-meaning words such as "table," meaning "chart" or "means," meaning "averages." This mathematics language can become cryptic to students who speak another language that is different from standardized English (Crystal, 2008).

Another obstacle that African American students face are homophones, where words sound the same and have different meanings, the word "hay" can be confused with the word "hey," as sound descriptors can give another meaning (Crystal, 2008). Another example is when using mathematics terms such as pie v. pi, where "pie" means a dessert and "pi" is a mathematics formula for circumference c = 3.14. Homophones sound the same when orally spoken but have a different spelling on paper.

Conjunctions can be another contributing factor to the misunderstanding of mathematics word problems (Bailey, 2018). Mathematics word problems primarily utilize coordinating, subordinating, and correlative conjunctions. Subordinating conjunctions have an independent clause, which is a sentence that can stand alone and a dependent clause that extends or provides more information in the sentence (Bailey, 2018). For example, if a mathematics word problem reads, “Sally had four buckets of oranges, although she has two more buckets of oranges at her aunt’s house.” “Sally had four buckets of oranges” is the “independent clause” and “although” is the subordinating clause. The other part of the sentence is the “dependent clause” because it cannot exist without the independent clause at the beginning.

A coordinating conjunction is a word group that contains a subject and a predicate (Bailey, 2018). For example, the sentence reads, “Sally had four buckets of oranges but gave one bucket to her brother.” The word “but” or “and” are the most common coordinating conjunctions mentioned in mathematics word problems. On the other hand, correlative conjunctions work together in different places of a statement, thus making it connect. For example, if the sentence reads, “Sally wants either the bucket of oranges or the box of green apples.” The word “either” and “or” are the tag team conjunctions connecting the compound sentences. Students must understand that there are multiple sentences in a mathematics word problem, and they need to break down and analyze the sentence, thus configuring the “situation” for solving (Bailey, 2018).

Mathematics sentences describing events that are both past and present tense can become more involved with more than one subordinate conjunction or a verb (Hawkins, 2014). For example, this mathematics sentence reads, “When I was half as old as I am now, I was 15 years younger than I will be when I am twice as old as I am now” (Texas Education Agency, 2019, p. 13). There are six verbs in the mathematics sentence. The word “was” appears two times, while “am” appears three times, and “will be” is used one time. The subordinate conjunction “when” appears two times, while “as” appears two times, and “than” was utilized one time. This mathematics word problem can be confusing for students who do not practice standardized English in their homes.

Language support for connecting children to standardized English has always been in place for most school districts. However, Ebonics is a vernacular language spoken in African American homes but is not considered a foreign language. The research indicates there are supports with ELLs whose language is foreign from standardized English, but not for languages that derived from standardized English (U.S. Census Bureau, 2010). Research also indicates reading classes have linguistic support for ELLs for the comprehension of literature, but not for mathematics (Kim, 2011; Guglielmi, 2012; Orosco, 2014; Orosco et al., 2011). The research implies that reading comprehension and linguistic support is necessary beyond computation strategies with mathematics word problems (Crystal, 2008; Hawkins, 2014). The only language in the classroom is mathematics, which has both mathematics computation and Anglocentric text.

### *Ebonics at Home*

Ebonics is a dialect of standardized English used in the homes of African American families. Many African American students who live in low-socioeconomic neighborhoods have little exposure to standardized English, which creates a tremendous gap between standardized English in the classroom and the ethnolinguistics spoken within the household (S. E. Anderson, 1990). Research suggests that Ebonics derives from a low socioeconomic AAVE environment (S. E. Anderson, 1990; William, 1997).

Linguists argue Ebonics derives from standardized English and does not represent a native language (Hollie, 2000; Swisher, 2012; Warner, 2007).

African American psychologist Robert Williams and linguistics analyst Ernie Smith created the word Ebonics in 1973 during the “Cognitive and Language Development of the Black Child” conference in St. Louis (William, 1997). The linguistics community did not recognize Ebonics until 1996, when the School Board in Oakland, California, deemed Ebonics as a primary language (Smitherman, 2000). In 1997, the Oakland Unified School District created a program to supplement the learning of African American students by teaching Black English, which is also known as Ebonics. The goal of the Oakland Unified School District was to teach students how to code-switch from the home environment to the school environment as a way to transition in and out of both environments. The goal was for other school districts to incorporate Ebonics just as the Oakland Unified School District, which set the bar for ethnolinguistic learning. Some examples of Ebonics are words such as “phat,” which means “excellent” and not concerning the standard English text of “fat” when being spoken. Another example of Ebonics is “Off the hook,” which means “Excited,” and not “Out of trouble” (Smitherman & Geneva, 2000). The school district attempted to transition students from Ebonics to standardized English enabling them to codeswitch. African American students could preserve their cultural language while learning standardized English not frequently used in their households.

In 1997, the Oakland Unified School District had an African American population of 53%, with 80% of these students maintaining a D average (Perry, 1999, p. 3). In other cities, African American scores mirrored the results of the Oakland Unified School

District as the average GPA was 1.8 (Harper et al., 1998; Ogbu, 1999). The Oakland Unified School District established a task force to analyze the problem. The task force found the difference between the Black children's language at home and standard English was the main root of low scores (Ogbu, 1999). According to Harper et al. (1998), standardized English is a proficiency learning goal for African American students, and yet Ebonics is a legitimate language within the community that society cannot ignore.

The Oakland Unified School District official program never came to fruition due to politicians' distaste for the language of Ebonics as they viewed the program as counter to standardized English. However, the Oakland Unified School District used earlier Ebonics techniques to aid African American students in the classroom during the 1970s. The earlier techniques utilized AAVE, which uses dialect as a way to check for understanding from standardized English to Ebonics (Hollie, 2000; Swisher, 2012; Warner, 2007).

During the 1970s in the Oakland Unified School District, teachers used the read and recall approach where the teachers read a story. Then teachers would ask African American students to recall the story in their home language. "Black Artful" was the technique coined by researcher Ann McCormick Piestrup, which encouraged students to participate and hear both Ebonics and standardized English together (Hollie, 2000; Swisher, 2012; Warner, 2007). "Black Artful" is code-switching between AAVE and standardized English (Hollie, 2000; Swisher, 2012; Warner, 2007). For example, if the sentence reads, "They told him, they said you'd better not go there," then the teacher would ask the student to recall what they read (Mufwene et al., 1998, p. 15). When students had to recall what they read, then they would say, "They tell him to say, you better not go there" (p. 15). The teacher would identify "said" with "say" and "told" with "tell" as a way of interpreting the AAVE spoken by African American students. The teacher bridged the gap and understood the AAVE version of standardized English. AAVE techniques in the classroom helped bridge the gap between Ebonics and standardized English (Hollie, 2000).

The Ravenwood City and the East Palo Alto School Districts used a similar program where teachers read the stories and African American students would recall the story in Ebonics. The Standardized English Program was a program where teachers train to understand the linguistic patterns of Black speech and transition student's dialect into standardized English (Connor & Craig, 2006; Murray, 1995). According to Hollie (2000), Piestrup realized that when teachers used this technique, the scores for African American students increased, and student attitudes towards learning became positive. The pioneers of integrating Ebonics into the school curriculum are Oakland Unified School District, Palo Alto School District, and Ravenwood City School District. Other states have not adopted AAVE techniques nor recognize Ebonics as another linguistic language as standardized English text dominates the school curriculum (Americans United for Separation of Church and State, 2014; Gewertz, 2015; Strauss, 2014).

According to the U.S. Census Bureau (2010), there are four groups of classified languages spoken in U.S. homes, which do not include the language of Ebonics. The United States U.S. Census Bureau (2010) reported over 100,000 people in each county where about 25,000 people that speak Spanish or another language (U.S. Census Bureau, 2010). Based on the U.S. Census Bureau (2010), out of 291,484, 482 people reported in the United States, only 231,122,908 people identified as English speakers, which is 80%

of the United States population. There were 894,499 African languages reported, which is 0.30% of the American population. The African languages included Amharic, Somalia, Afro-Asiatic, Yoruba, Twi, Igbo, and other Western African languages (U.S. Census Bureau, 2010). Among these languages, the data collection did not include Ebonics.

The Oakland Unified School District and other surrounding districts support their teachers in learning Ebonics as a way to transition the learning to standardized English. There is no other research on AAVE practices in other school districts in the United States. Northern California recognizes Ebonics as a vernacular language but not as a native language. The U.S. Census Bureau (2010) has yet to recognize Ebonics as an African language or a language of its own. Linguists believe that Ebonics is an old version of standardized English and that they favor AAVE practices within the classroom. There is not enough data to suggest that all African Americans speak "Ebonics," although urban neighborhoods are highly populated by AAVE speakers. There is still debate over whether there should be a curriculum for Ebonics or if teachers should learn Ebonics and integrate the culture into the learning experience.

### *Culturally Relevant Education Practices*

Many African Americans and minorities face adversity in an education system that caters to Anglocentric perspectives. Psychological distress and low academic scores are the outcomes for students who feel alienated in the educational environment that does not incorporate their home culture (Fullam, 2017). CRE can create environments that connect both the teacher and the student during instruction. CRE practices concentrate on the diverse and low-socioeconomic groups that are at a disadvantage due to policies, beliefs, and practices that are Anglocentric (B. A. Brown et al., 2019).

CRE practices connect to all cultural aspects such as gender, class, sexuality, ethnicity, race, and language. Ladson-Billings (1997) and Gay (2018) define CRE practices as understanding the culture of the classroom, performance styles of students from diverse backgrounds, and using prior knowledge to create multicultural experiences within the classroom. Ladson-Billings (1997) and Gay (2018) emphasize teachers should analyze textbooks in how they translate to teaching and learning. According to Ladson-Billings (1997) and Gay (2018) some of the tenants for CRE practices for the classroom include: connecting students to real-world learning, acknowledging student contributions, being consistent with behavior expectations for all students, incorporating multiculturalism within the classroom, and responding to the feedback of students.

There are many aspects of CRE practices inside the classroom. One of the aspects of CRE practices is acknowledging student contributions regarding multiculturalism used inside the classroom. The Los Angeles Unified School District (LAUSD) uses CRE practices in the classroom, specifically for cultural and linguistic purposes. In 2001, LAUSD created its CRE program that would improve teachers' instructional methods, the teacher as an individual, and school administrators (Fullam, 2017). The main goal was to eliminate the gap between Black and Latino student's performance with White students as their cultural backgrounds deserve special attention. According to Fullam (2017), the student percentage of Black and Latino students at LAUSD is about 87%, where the majority of teachers are White females. Teachers and other faculty members learn CRE methods while implementing these practices into their daily instruction. Even though there is daily personal development training, CRE practices in LAUSD are optional and not a requirement (LAUSD, 2017). The CRE standards for both general education and special education teachers could be the key to eliminating the achievement gap for African American students. However, LAUSD continues to struggle with CRE reform and test scores remain at 40% passing for reading, and 30% for math (LAUSD, 2017).

The language of students whose first language is not standardized English is essential to academic learning. CRE practices with ELLs can improve motivation and creative agency for students. For example, the after-school program for Lao students revolves around the traditions and cultures of the Lao heritage (Aronson & Laughter, 2016). Souryasack and Lee (2007) placed seven students in this 9-week program where the teachers would respond to them with newspapers and poetry from the Lao heritage. Even though only three students finished the program, the increase in writing improved due to emphasis on personal connections with the home culture. School districts can use the same after-school program to improve the English language with African American students who speak Ebonics in their households.

Another aspect of CRE practices is making the incorporation of real-world applications such as the personal lives of students into the lesson. For example, Mose's Algebra Project focused on issues with mathematics jargon on the civil rights era with African American students (Moses & Cobb, 2002). Moses and Cobb (2002) discovered that math teachers found ways to connect mathematics learning with real-world scenarios related to the civil rights movement and this ignited the student's interest in learning math. Civil and Khan (2001) used real word experiences by connecting teachers, parents, and students in a gardening project. Throughout the project, students from different grade levels were able to converse in "math talk" while gardening with their parents (Aronson

& Laughter, 2016). Utilization of terms such as perimeter and area during the project gave students a personal connection to their learning. Ensign (2003) realized that personal experiences, for example, buying candy, had more of a connection, thereby raising students' interest levels. Although CRE practices in mathematics are not often available due to the lack of professional development, integrating the students' culture into the curriculum remains critical (Aronson & Laughter, 2016).

Although there is little to no evidence of CRE practices with African American students, there is partial evidence of CRE practices in some classroom environments. Ladson Billings (1997) conducted a 3-year research study on teachers who were successful in CRE practices with African American students. The study concluded that teachers believed in all their students, regardless of socioeconomic status, and invited community guest speakers to incorporate cultural learning. Teachers had a strong relationship with their students and encouraged them to work together. Teachers scaffolded lessons and incorporated the culture of students into classroom learning, which motivated students. There is minimum preparation for teachers when it comes to CRE practices with African American students (Gay, 2018; Ladson-Billings, 1997). Despite the evidence in favor of CRE, many educators and policymakers continue to ignore the solutions for closing the achievement gap with African American students.

### *Conclusion*

The achievement gap between African American students and White students is significant due to the hegemony of Anglocentric textbooks manipulated by the Texas State Board of Education. Mathematics text is a combination of mathematics jargon and standardized English, which can be foreign to the African American community. Ebonics is a vernacular language that is not taken seriously by educators or policymakers as they consider the language as an underrated version of standardized English. Policymakers and educators do not consider Ebonics as a native language, which excludes African American students from language programs within the school system. CRE practices with language and mathematics can help with closing the achievement gap for African American students in mathematics. The following chapter explains the explanatory sequential mixed methods design, outlines the research methodology, describes the procedures for gathering and analyzing quantitative data as well as details the qualitative methods applied in this study.

# CHAPTER THREE

## Methodology

### *Introduction*

This research study explained how urban middle school African American students perceived the linguistic jargon applied in mathematics word problems through the lens of culturally relevant education (CRE). The researcher utilized an explanatory sequential mixed-method approach with three phases. In the quantitative data collection phase of the research study, the researcher collected data from a group of seventh graders at an urban middle school using the TOMA-3 (V. L. Brown et al., 2012) instrument. The research required collecting quantitative data, concentrating on the math word problems, computation, and attitudes sections of the TOMA-3 instrument. The researcher analyzed the data from the TOMA-3 before transitioning into the qualitative phase.

During the qualitative data collection phase, the researcher explored African American student perceptions through semi-structured interviews with four students who had the largest difference between their word problems and their computation scores on the TOMA-3 (V. L. Brown et al., 2012) instrument. The collection of qualitative data expanded upon the attitudes section of the TOMA-3. The researcher analyzed the qualitative data before examining the integrated quantitative and qualitative results. The final phase of this mixed methods study integrated the two data types to explain descriptive and statistical results. Qualitative themes enhanced the quantitative findings of the research.

The research questions in this study focused on linguistics within mathematics word problems related to the TOMA-3 (V. L. Brown et al., 2012) instrument. The research questions explored how language serves as a barrier to mathematics performance. The researcher hypothesized that African American students would perform better on computations than mathematics word problems. To gain a deeper understanding of the research, this explanatory sequential mixed methods approach addressed the following research questions:

1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance?
2. What contributed to African American middle school students' performance between math computations in comparison to word problems?
3. How do the themes that emerged from the interview with African American middle school students explain the quantitative math attitude, computation, and word problem scores?

The following sections outline the researcher's perspective, theoretical framework, research design, site selection, participants, data collection procedures, data analysis procedures, ethical consideration, limitations, delimitations, and conclusion.

### *Researcher Perspective*

The lack of empirical research on how African American students solve math word problems served as my motivation for this research. The U.S. Census Bureau (2010) identified four of the most frequently spoken languages in the average American home: English, Spanish, Chinese, and Tagalog. The U.S. Census Bureau notably excluded Ebonics. The disregard for specializing the curriculum for African American students' language contributes to policymakers catering to White middle-class American families.

My commitment to education derives from my passion for uplifting young African American students in academia and promoting career-driven scholars who will lead the future. As an African American student, I experienced the same difficulties that my students experience with Anglocentric textbooks. As an instructor of mathematics, I believe I can help to remedy the situation.

As an educator in the public school system, I witness a difference in students from middle-class households and low-socioeconomic households. From my experience, students from middle-class households are exposed to standardized English and Anglocentric texts regularly. While low-socioeconomics students in urban areas have limited in-home exposure and modeling, yet Standardized English and Anglocentric text is utilized within their educational environments. As a K–12 educator in the middle school sector, I believe teaching children who face adversity within the school district relies heavily on teachers trained in CRE (Ladson-Billings, 1997). Teachers trained in CRE consider and value the students home life and language.

As an emerging scholar at Baylor University, I hold myself responsible and have a civic duty to create an outline for training teachers in culturally relevant pedagogy practices specific to African American youths in the K–12 sector. As a part of this study, I reflected on my own biases and beliefs, and I recognize that my own experiences informed my pragmatic viewpoints as an African American male and educator. Additionally, my experiences as a member of the African American community prompted me to examine the social constructs between African American vernacular and standardized English when solving mathematics word problems.

A pragmatic perspective became necessary as I sought the truth on what worked for African American youth rather than speculating. This perspective influenced the mixed methods approach applied in this study. The purpose of this research facilitated the discovery of a phenomenon or root cause that disconnects African American youths from internalizing the mathematics syntax and standardized English found in mathematics word problems. My devotion to the research aimed to demonstrate the gap between African American middle school students' math computation skills and their ability to solve word problems to highlight how Anglocentric language limits these students' performances. Hearing the perspective of the student could illuminate this phenomenon.

I believe educational research and my pragmatic viewpoint could change the minds of policymakers and political leaders who deem African American vernacular as a downgrade to standardized English. Suppose educators broke the traditional norms of Anglocentric text and explored new ways to articulate mathematics word problems to African American youths, then the way African American students approach mathematics word problems could change as well. Throughout this study, I strived to be mindful of new perspectives revealed from the research. I remained committed to ensure that the research findings were authentic. Although I have a relationship with some of the students who were selected to participate in this research, I understand that the research results must tell the story and not my personal biases. This research is relevant to educators whose school population includes predominantly Black students.

### *Theoretical Framework*

The researcher utilized the CRE framework derived from the research perspectives of Ladson-Billings (1997) and Gay (2018). CRE practices incorporate constructive changes on several learning levels, such as instructional materials, classroom climate, instructional techniques, student-teacher relationships, and self-awareness to improve student learning (B. A. Brown et al., 2019; Ladson-Billings, 1997). CRE practices make meaningful connections with languages, cultures, and real-world experiences. The framework tenant on language informed this study. Language represents fundamental aspects of one's cultural identity. CRE encourages the use of culturally relevant language to express and transmit ideas throughout the learning process. This study utilizes this framework as a lens to explore how African American seventh grade students make sense of mathematics word problems.

CRE informs the study by selecting an instrument that quantifies and analyzes deficits between math problems that do not require linguistic interpretation, computations, and word problems. The researcher collected and analyzed data from the word problems and computation sections of the TOMA-3 (V. L. Brown et al., 2012) instrument. The data from the TOMA-3 determined if there was a difference in the student participants' mathematics performance between computations and word problems section. The researcher used the TOMA-3 instrument to determine if computation skills were consistent with data from the word problems section, followed by interviews to identify students' attitudes towards math, and how students make sense of word problems to decipher the "situation."

The researcher expanded on the attitude math perceptions subtest of the TOMA-3 (V. L. Brown et al., 2012) instrument by listening to seventh grade African American students to understand the connection with the students' feelings towards solving math word problems and whether standardized English served as a barrier to interpreting mathematics word problems. CRE informed the interview questions focusing on aspects of language used in the word problems and the lack of culturally relevant language. The researcher specifically focused on how students interpreted or misinterpreted what is being asked of them when solving math problems (see Appendix A for interview protocol).

*Research Design and Rationale*

The researcher utilized an explanatory sequential mixed methods design, QUAN→qual, where the researcher implemented two strands, one after another. The notation system QUAN→qual highlights a greater significance within the quantitative phase followed by the qualitative phase (Creswell & Plano Clark, 2017). Finally, the researcher merged the two sets of data found in both methods. This explanatory sequential mixed methods design drew on the strength of the TOMA-3 (V. L. Brown et al., 2012) instrument and in-depth semi-structured interviews, which minimized both approaches' limitations. The mixed methods approach created a complex and sophisticated procedure to discovering new perspectives on how African American middle school students decipher mathematics word problems during the "situation" (Creswell & Plano Clark, 2017).

The explanatory sequential mixed methods design involved data collection from 34 participants. The first research question focused on how the TOMA-3 (V. L. Brown et al., 2012) instrument assessed participants' attitudes, computational, and word problem skills in the study's quantitative phase. The researcher chose four students who had the largest difference between their word problems and their computation scores on the TOMA-3 for in-depth interviews.

Participants filled out the math perceptions subtest, which expressed their attitudes about their self-perceptions with mathematics. Questions focused on participants achievement and abilities as students answered (“Closer to yes,” “Yes definitely!” “No definitely,” or “Closer to no!”). There were no right or wrong answers, and the interviews elaborated on the participants’ attitude findings.

In the qualitative phase, interviews centered around the TOMA-3 (V. L. Brown et al., 2012) results provided an additional opportunity to understand how students approached solving mathematics word problems. In this phase, the interview questions addressed the Anglocentric text and mathematics language in math word problems, computations, and attitudes towards math (V. L. Brown et al., 2012). In the qualitative phase, the researcher explored what contributed to student interpretation of mathematics word problems. The researcher specifically explored how Anglocentric language may contribute to the misunderstanding. The nature of this explanatory sequential mixed methods design required the researcher to be familiar with both quantitative and qualitative data. This research design’s complexity necessitates a visual model to detail the research process (see Figure 1).

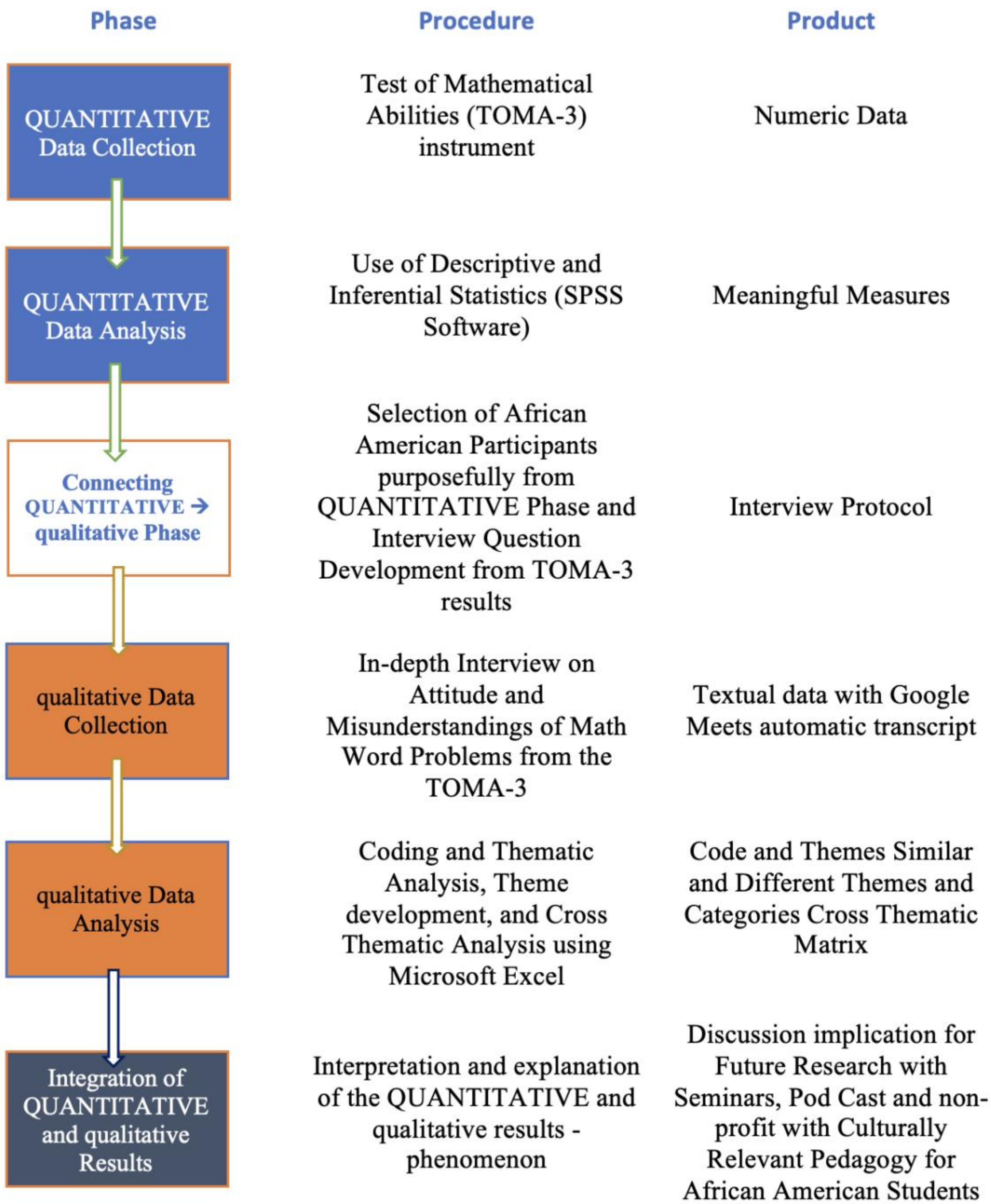



*Figure 1*. Explanatory mixed methods design.

*Site Selection and Participant Sampling*

Data collection took place at an urban middle school in southeast Texas (see Table 4). The urban middle school had 941 students, with 325 sixth graders, 300 seventh graders, and 316 eighth graders. This school's demographics included 62% African American, 31% Hispanic, 3% White, 2% Indian, 1% Asian, and 1% other (Texas Education Agency, 2020b). The student body consists of 78% labeled as at-risk, 69% economically disadvantaged, and 22% identified as limited English proficient. The accountability ratings ranked the middle school as an F grade for student achievement, school progress, and in closing the achievement gap.

The researcher conducted a power analysis to determine the sample size. The online Statulator (2014) tool for a paired samples Wilcoxon signed-rank test calculated that a sample of 34 is needed to determine a large effect size of .50. Therefore, the researcher recruited 34 African American seventh graders. Participants came from low-socioeconomic households that spoke African American vernacular. The researcher collected the demographic data through a Google survey (see Appendix B) to determine the free or reduced lunch, recent STAAR scores, and if Ebonics or slang is spoken regularly within the household. The purpose of the Google survey was to determine whether students matched the researcher's profile of African American students living in low-socioeconomic households. The researcher collected 54 responses from the demographic survey. The participant numbers dropped from 54 to 38 due to incomplete signatures from parent consent forms or parents who disagreed with their child participating in the study. All 38 participants met the requirement, but four did not show up for testing, which left the number of participants at 34.

Table 4

*Demographics Characteristics of Participant Population*

| Demographic Characteristics | School Population *N = 941* | Population % | Participant *N = 34* | Sample % |
|---|---|---|---|---|
| Sex | | | | |
| Male | 499 | 53 | 22 | 65 |
| Female | 442 | 47 | 12 | 35 |
| Race | | | | |
| Hispanic | 291 | 31 | 0 | 0 |
| Black/African American | 583 | 62 | 34 | 100 |
| White/Caucasian | 28 | 3 | 0 | 0 |
| Asian | 10 | 1 | 0 | 0 |
| Indian | 19 | 2 | 0 | 0 |
| Other/Not Reported | 10 | 1 | 0 | 0 |
| Grade (as of 4/19/2021) | | | | |
| 6 | 325 | 35 | 0 | 0 |
| 7 | 300 | 31 | 34 | 100 |
| 8 | 316 | 34 | 0 | 0 |
| Age (as of 4/19/2021) | | | | |
| 13 | N/A | - | 17 | 50 |
| 14 | N/A | - | 10 | 29 |
| 15 | N/A | - | 6 | 18 |
| 16 | N/A | - | 1 | 3 |
| Economically Disadvantaged | | | | |
| Economically Disadvantaged | | 92.7 | | |
| Free Lunch Eligible | 766 | 81.4 | 34 | 100 |
| Reduced Lunch Eligible | 103 | 11.3 | 0 | 0 |

Out of the 34 participants, the researcher chose four students for the qualitative phase of the research. The qualitative sampling included purposive sampling that focused on seventh-grade African American students from low-socioeconomic households who spoke African American vernacular at home. Specifically, the four participants for the interviews had the largest difference between their computation and math word problem scores on the TOMA-3 (V. L. Brown et al., 2012) instrument.

## *Data Collection*

To be eligible to participate, parents provided informed consent (see Appendix C), and student participants completed assent forms (see Appendix D). The researcher obtained research, evaluation, and data permission forms from the school district of the data collection site that authorized named individuals to conduct research on-site or with students in general. The researcher obtained a campus-based review board (IRB) approval from Baylor University to conduct research with human subjects (see Appendix E). Next, the researcher collected demographic information through a Google online survey to verify students met the eligibility criteria.

### *Quantitative Data Collection*

Quantitative data collection utilized participants' numeric scores from the TOMA-3 (V. L. Brown et al., 2012) instrument to determine mathematics competency and attitudes. The TOMA-3 instrument is an assessment tool to quantify, identify, and describe mathematics deficits with school-age children. The TOMA-3 instrument has four core areas: computation, math in everyday life, word problems, and mathematics symbols with concepts. The fifth supplemental area focuses on attitudes and perceptions of mathematics. To address the research questions for this study, the researcher selected only the computation (Subtest 2, 40 questions), word problems (Subtest 4, 30 questions), and attitudes toward math (Subtest 5, 15 questions) subtests.

The researcher followed TOMA-3 administration instructions provided in the Examiners Manual (V. L. Brown et al., 2012a). The administration of the TOMA-3 can be with one individual or to a group of students, and the researcher opted for a more efficient group administration. Each subtest requires 20 minutes for completion, and the administration of the subtests can be either individually taken or all at once. The TOMA-3 Examiner's Manual provides tables to convert raw scores to age/grade equivalents, scaled scores, percentile ranks, and a mathematics ability index (V. L. Brown et al., 2012a).

The TOMA-3 is a reliable instrument. Cronbach's (1951) coefficient alphas measured internal reliability/consistency for the normative sample of 11–13-year-olds were .88 for the computation subtest, .88 to .90 for the word problem subtest, and .87 to .88 for the math attitudes subtest (V.L. Brown et al., 2013b). Coefficient alphas for the Black student normative sample ($n$ = 161) were also strong at .92, .90, and .88 for Subtests 2, 4, and 5, respectively. Test-retest reliability (with two weeks between administrations) for the three subtests was also strong as the uncorrelated correlation coefficient was .88, .83, and .89 (V. L. Brown et al., 2012a).

The test questions in the TOMA-3 contained representative and reputable sources, which enhances content validity. The computation Subtest 2 followed the National Council of Teachers in Mathematics Number and Operations outcome expectations and is similar to other well-known math ability tests (V. L. Brown et al., 2012) such as the Comprehensive Mathematics Abilities Test (Hresko et al., 2002) and the Test of Early

Mathematics Ability-Third Edition (Ginsburg & Baroody, 2003). The *World Almanac and Book of Facts* (Janssen, 2020) provided content for the word problems in Subtest 4. Finally, the Attitude Toward Math (Subtest 5) is similar to Estes Attitude Scales (Estes et al., 1981). However, instead of three response options, four response options are provided for the 15 test items: *Yes, definitely!, Closer to Yes*, *Closer to No*, and *No, definitely!* (V. L. Brown et al., 2012a, p. 32).

The TOMA-3 is a valid instrument (V. L. Brown et al., 2012). Validation occurred using a norming sample of 1,456 students ranging from 8 to 18 years old. The normative sample was consistent with U.S. Census data on the following characteristics: gender, race, household income, and parent educational attainment. The evaluation of the TOMA-3 had evidence of criterion-prediction validity by comparing the test with the Iowa Algebra Aptitude Test Fifth Edition and Comprehension Mathematics Abilities Test, which indicated a correlation of .92 and .83, respectively (Schoen & Ashley, 2005; Hresko et al., 2003). The TOMA-3 sensitivity is .95 and has a specification of .79 in classifying students with and without mathematics disabilities (Schoen & Ashley, 2005; Hresko et al., 2003). Confirmatory factor analysis suggested the four core subtests measure a single mathematics ability factor (V. L. Brown et al., 2012a). The factor loadings were .80 for computation and .82 for word problem subtests, indicating a strong association between the subtests and the mathematics ability. Finally, results from differential item functioning suggest the test is not biased for African Americans than non-African American students or males compared to females. Given the validity and reliability evidence, it is reasonable to "conclude that the TOMA-3 is a valid measure of mathematics abilities" and "Examiners can use the test with confidence, especially for assessing individuals for whom most other tests might be biased or otherwise inappropriate" (V. L. Brown et al., 2012a, p. 45).

The researcher administered the TOMA-3 (V. L. Brown et al., 2013) to 34 African American students in seventh grade from ages 13–16. The researcher determined raw scores for the math word problems, computations, and attitudes subtests of the TOMA-3 in the manner prescribed by the test developers (V. L. Brown et al., 2012). The investigator converted raw scores to scaled score categories. Before proceeding to the next stage of data collection, the researcher analyzed participant responses to inform the qualitative phase selection.

### *Qualitative Data Collection*

The second phase of data collection involved the qualitative method, which utilized semi-structured interviews to explain TOMA-3 (V. L. Brown et al., 2012) test results. Through the quantitative results, the researcher identified four African American participants who spoke African American vernacular at home and who had the largest difference in their computations and math word problem scores on the TOMA-3 instrument. The researcher purposefully selected four African American students and conducted an in-depth study of each person's experiences and perceptions with solving mathematics word problems. Data collection utilized one-on-one semi-structured interviews through Zoom using protocols to identify the mathematics language found in the word problems section of the TOMA-3. The researcher utilized the Zoom chat recording to transcribe the conversation using the embedded transcript capture feature. The interviews occurred over a week, with each interview lasting 45 minutes. Each participant engaged in one interview.

One research method alone did not suffice to capture the trends and details of complex "situations" such as solving math word problems written in jargon that differs from the student's home language. The quantitative data provided a general picture of the research problem. The qualitative data analysis refined and explained the results of the TOMA-3 by exploring the participant's perceptions regarding the "situation" in math word problems.

## *Data Analysis Procedures*

The researcher utilized the TOMA-3 (V. L. Brown et al., 2012a) to develop reliable and valid data. When determining the measurement of students' mathematics ability, the researcher collected the data derived from the math computations, mathematics word problems, and math attitudes section to analyze the results. This section discusses these data analysis procedures.

### *Quantitative Data Analysis Procedures*

The TOMA-3 (V. L. Brown et al., 2012a) served as a norm-referenced math test for school-aged children that the researcher used to help identify students who struggle to comprehend math when expressed in standard English. The investigation began with converting the raw score from the TOMA-3 into the standardized score category in the quantitative data analysis. The researcher entered the participants' raw scores and standardized scores for each subsection into IBM® SPSS® Statistics (v. 27) for further analysis. The investigator checked the data for completeness, normality, and potential outliers.

The investigator had originally planned to use a paired samples or dependent samples *t*-test to compare differences in students' mathematics abilities with math word problems and computations on the TOMA-3 (V. L. Brown et al., 2012). As the data did not meet parametric assumptions, the researcher selected a non-parametric Wilcoxon signed-rank test for examining the two subtest scores from the same participants (Field, 2018). Conducting a Wilcoxon signed-rank test for the quantitative analysis allowed the researcher to determine if African American middle school students scored significantly higher on the computations section than the math word problems section of the TOMA-3. The researcher hypothesized that if African American middle school students scored higher on the computations section than the math word problems section, the language of word problems prevented their similar performance in solving math word problems.

The researcher performed a correlation coefficient analysis to address the second part of the first research question. SPSS calculated Pearson's *r* correlation coefficients to indicate the relationship or correlation between the scaled scores for the three subtests: math computation, word problems, and attitude toward math subtests. This analysis helped to determine if student attitudes towards math significantly correlated with their performance.

*Qualitative Data Analysis Procedures*

The researcher chose to conduct the qualitative analysis to determine what contributed to African American middle school students' differences in their performances between math computations and word problems. Additionally, the qualitative inquiry explored how language contributed to misunderstandings of the mathematics word problems. The researcher transcribed the qualitative data from interviews with four African American students who had the most significant difference in their computations and math word problem scores on the TOMA-3 (V. L. Brown et al.,

2012) instrument. The researcher organized the semi-structured interviews into word processing files using a verbatim transcription of the interview. During the transcription process, the researcher verified the accuracy and then formatted the transcripts to organize the data into descriptions, codes, and categories (Creswell & Plano Clark, 2017).

The researcher utilized Google Cloud for storing messages and recordings from the participants, which made the data easily accessible for analysis. The researcher identified central themes by examining the transcripts. The researcher organized the data into specialized folders on a Mac computer and incorporated data into relatable codes using Microsoft Excel, where comparing and contrasting sentiment codes helped make connections. The researcher reviewed all data forms from interview transcripts and annotation notes on the TOMA-3 math word problems section. The coding process aided with finding evidence of possible patterns between students. The researcher identified the most frequently occurring words, vocabulary, and numeric text in interviews with relation to the TOMA-3 (V. L. Brown et al., 2012) test. The researcher compared results with the data in the quantitative analysis to determine the relationship with the qualitative data. The utilization of qualitative data allowed for a more in-depth interpretation of the quantitative findings using inferences.

The qualitative research's reliability and validity relied on structural corroboration. The structural corroboration involves the utilization of multiple sources of evidence (Creswell & Plano Clark, 2017). The researcher achieved validity based on the confluence of evidence captured with both the quantitative data and the qualitative data including semi-structured interviews, interpretations, observations, and conclusions. The researcher compiled pieces of evidence to create a whole picture. The researcher's use of the validation process for accuracy in the findings by participants involved a combination of qualitative research strategies such as thick description, extensive field time, and the closeness of the researcher to the participants (Creswell & Plano Clark, 2017). The researcher illuminated the subject matter by bringing about sensitive human perception, complexity, and understanding on whether language is the issue to low math test scores with African American middle school students.

*Integration of Quantitative and Qualitative Data*

Using the results from the quantitative analysis, four participants out of 34 were purposefully selected based on the largest difference between their math computations and mathematics word problems score. The quantitative results informed the interview questions used in the qualitative analysis stage. Then the researcher analyzed the quantitative and qualitative data during the integration stage by utilizing a joint display table. Based on Finley et al. (2013), a joint display table is suitable for the explanatory sequential mixed methods analysis. The joint display table highlighted the quantitative scores from the TOMA-3 (V. L. Brown et al., 2012) with the qualitative results side by side. This allowed for a direct comparison of the results and assisted in interpreting how the qualitative analysis results explained the statistical findings found in the quantitative phase. The quantitative results from the TOMA-3 had a variation between math word problem section, computation section, and attitudes sections. The statistics by theme joint display represented how the academic group variables linked with the qualitative themes found in the semi-structured interviews to conduct the mixed methods analysis.

### *Ethical Considerations*

Ethical considerations include concerns such as the time necessary to recruit participants due to STAAR prep and testing in March. The researcher respected the urban middle school site during the TOMA-3 (V. L. Brown et al., 2012) testing and did not interrupt the daily work activities. The researcher facilitated semi-structured interviews after school through Zoom chat to avoid interrupting regular school instruction hours. Participants who tested with the TOMA-3 received snacks and refreshments as compensation for their time during the school day. The four interview participants received a $25 gift card for their participation. The researcher concealed the participants' identities as each participant received a number to write on their test booklet instead of writing their real names. The researcher used standardized procedures to conduct testing and interviews and implemented data collection mandates to protect the participants' information and minimize discriminatory behavior. The researcher collected parent consent, participant assent, the research site consent, which are all mandatory forms for conducting standardized research (Creswell & Plano Clark, 2017).

### *Limitations and Delimitations*

The research limitations included hybrid classes where only half of the African American population is available for onsite testing. The researcher administered the TOMA-3 (V. L. Brown et al., 2012) onsite as online testing threatened to create biases and skew the data without the proper testing procedures mandated in person. Using an online platform can create opportunities for students to use calculators or enlisting help during testing. COVID 19, and social distancing prevented interviews from being face-to-face. Given that the participants came from one middle school that had an F rating, the results may not be generalized to all middle schools in the district. Some participants who completed the TOMA-3 test were classified as Special Education and 504, which can influence scores. The participants chosen for interviews did not classify as Special Education or 504. The research did not investigate if participants who were between the ages 15 and 16 years were held back a grade level at some point or started school at a later age. These limitations set the boundaries in conducting valid and reliable research.

The researcher also made choices resulting in delimitations. First, the researcher selected participants based on specific characteristics. Participants were African American students, from a low socioeconomic household, and spoke Ebonics. Other characteristics required students to currently be in the seventh grade. Additionally, all students attended an F-rating middle school. The researcher also chose to utilize the Test of Mathematics Abilities (TOMA-3) to assess the mathematics abilities of African American students in the seventh grade. The researcher also chose an explanatory sequential mixed methods study because the experiences of African American students could indicate why their scores are historically lower than their White counterparts.

### *Conclusion*

The researcher utilized an explanatory sequential mixed methods design to conduct this study. First, the researcher compared scores on the mathematics word problems and computation sections of the TOMA-3 (V. L. Brown et al., 2012) instrument. Then, the researcher examined the perceptions of African American students regarding mathematics word problems The researcher examined the quantitative and qualitative data. The qualitative data assisted in explaining the student scores. Data from the statistics by theme joint display connected with themes from the semi-structured interviews, which revealed patterns in the mixed method findings. The following Chapter Four discusses the results and the implications of the research findings.

# CHAPTER FOUR

# Results

## *Introduction*

In this explanatory sequential mixed methods study, the researcher applied both a quantitative and a qualitative data analysis process. The researcher first gathered and investigated the quantitative data, which measured the data using a norm-referenced, validated instrument, the TOMA-3 (V.L. Brown et al., 2012) for validity. The quantitative analysis results drove the qualitative sample selection and the qualitative data collection. Using this explanatory mixed methods study, the researcher aimed to explore how the language of mathematics affects African American students when solving mathematics word problems through the lens of CRE. The results from the TOMA-3 were used to determine if there was a significant difference between mathematics word problems and computations scores. The qualitative phase explored student experiences and perspectives related to solving mathematics word problems. This provided a deeper understanding of the quantitative data. Then the integration of both qualitative and quantitative data created a larger picture, which uncovered the phenomenon of deciphering language within mathematics word problems through the lens of seventh grade African American students from a low-socioeconomic environment who attend an urban middle school in southeast Texas.

The researcher utilized two methodologies to explore how African American students perceive the language within mathematics word problems using the TOMA-3 (V. L. Brown et al., 2012). First, the researcher administered the math attitudes, computations, and mathematics word problem subsections of the TOMA-3 to 34 African American students who were in seventh grade. According to the test protocol (V. L. Brown et al., 2012a), students have 20 minutes to complete each section of the TOMA-3. The TOMA-3, as mentioned in Chapter Three, is an instrument designed to measure math deficits in youths. A Wilcoxon signed-rank test was conducted to determine if African American students scored significantly higher in computations compared to math word problems. The researcher implemented the Attitude Toward Math perceptions subtest from the TOMA-3 to examine how African American students perceived their own math abilities and math attitudes. The attitudes math perceptions subtest results helped to finalize the one-on-one semi-structured interview questions. The researcher chose four participants who had the largest difference between the computations and the mathematics word problems scores of the TOMA-3 for interviews. Based on the framework of CRE, using semi-structured interviews, the researcher explored how students experience language with mathematics word problems. Each interview was 45 minutes and was conducted through Zoom. The researcher collected the text transcript through Zoom Cloud services to analyze the qualitative data. Specifically, the researcher conducted an inductive thematic analysis utilizing the data captured during the semi-structured interviews. The researcher interpreted the qualitative data by chunking data and organizing into themes and conclusions.

The data collection process allowed the researcher to examine the quantitative and qualitative research questions regarding African American student perceptions and attitudes towards solving mathematics word problems at an urban middle school in southeast Texas. The qualitative method for conducting interviews were used to elaborate the findings from the quantitative data. Both methodologies lead to the mixed methods research question, which merged the quantitative and qualitative findings and provided an in-depth analysis of the research findings. The study was guided by the following research questions:

1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance?
2. What contributed to African American middle school students' performance between math computations in comparison to word problems?
3. How do the themes that emerged from the interview with African American middle school students explain the quantitative math attitude, computation, and word problem scores?

The presentation of this chapter unfolds in three sections. The first section is a discussion of the quantitative research findings, which corresponds with the first research question. The quantitative findings discussion includes the Wilcoxon signed-rank test analysis results and the relationship between the math computations, math word problems, and math attitudes subtests from the TOMA-3 (V. L. Brown et al., 2012). In the qualitative findings, the researcher discusses the semi-structured interview results, themes, and codes utilized in a thematic analysis to answer the second research question. The third section is a dialogue on the mixed methods research findings, which addresses Research Question 3. The mixed methods findings are a discussion of the conclusions from the TOMA-3 and the semi-structured interview results.

## *Quantitative Findings*

The researcher developed the first research question, "Do African American middle school students score significantly lower on the word problem than the computation subtests of the TOMA-3, and do their attitudes towards math correlate with their performance?”

The section begins with a discussion on the data preparation. Next, the researcher’s investigation of the assumptions related to each proposed statistical analysis is reviewed. After that, the section covers the descriptive statistics for the math attitudes, computations, and mathematics word problems. The quantitative findings conclude with a section discussing the results of the quantitative analysis using non-parametric tests for data analysis.

*Data Preparation*

The first step in the data preparation included scoring the students’ TOMA-3 tests. Based on the TOMA-3 Examiners Manual (V. L. Brown et al., 2012a), raw scores are computed by scoring the student’s response using an answer key. Raw scores are determined by marking each question correct or incorrect based on the answer key. Each correctly answered question has a value of 1 and an incorrect answer has a value of 0. When a participant missed three questions in a row, the grading reached the ceiling, meaning that this is the cut off for scoring.

Test administrators can use the *Examiner’s Manual* (V. L. Brown et al., 2012a) to convert raw scores into scaled scores, percentile ranks, and descriptive term to categorize student performance that considers the student’s chronological age. The researcher calculated each student’s chronological age by subtracting the date of birth of each participant from the date of the test. For example, if Steve was born on January 9, 2007, and tested on April 14, 2021, then the months would read as (April (4) - Jan (1) = 3), days (14 – 9 = 5). The years would read as (2021 -2007 = 14), which indicates that the student is 14 years old, 3 months and 5 days old (V. L. Brown et al., 2013a). For example, the researcher first calculated Steve's raw score and his chronological age. Assuming he was 14 years old and had a raw score of 15 on the computation's subtest, the researcher would use Table D.10 from the TOMA-3 Examiners Manual. "A raw score of 15 is equivalent to a scale score of 6, scoring at the 9th-percentile" (V. L. Brown et al., 2013a, p. 73). Scaled scores determine the categorical performance descriptor: very poor, poor, below average, average, above average, superior, and very superior (Table 5). Scaled scores are a type of standard score, which has a mean of 10 and a standard deviation of 3. The TOMA-3 (V. L. Brown et al., 2013a) uses the 10:3 distribution for calculating scores due to alignment with the Test of Mathematics Abilities for Gifted Students (Ryser & Johnsen, 1998), the Test of Early Mathematics Ability-Third Edition (Ginsburg & Baroody, 2003), and the Comprehensive Mathematics Abilities Test (Hresko et al., 2002).

Student performance categories based on scaled scores and raw scores are reported in Table 5. As mentioned previously, scaled scores are calculated using students' age, not their grade. Therefore, students who are older than the traditional age of 13 may have lower scaled scores than their seventh-grade peers who had the same raw score. As percentiles and performance categories are tied to age-based scaled scores, those categorizations negatively affect descriptive categorizations for older students. For example, Table 5 shows more students are categorized as poor or very poor (39%, $n = 13$) on the computation's subtest using scaled scores based on age compared to students' raw scores (27%, $n = 9$).

Table 5

*Participants' TOMA -3 Raw, Scaled, Categorized and Percentile*

| Subtest Performance | Percentile Equivalent | Using | | | |
|---|---|---|---|---|---|
| | | Scaled Scores | | Raw Scores | |
| | | *n* | % | *N* | % |
| Computations Subtest | | | | | |
| Very Poor | ≥ 1 | 5 | 15 | 4 | 12 |
| Poor | 2–5 | 8 | 24 | 5 | 15 |
| Below Average | 9–16 | 6 | 18 | 8 | 24 |
| Average | 25–75 | 14 | 41 | 16 | 47 |
| Above Average | 84–91 | 1 | 3 | 1 | 3 |
| Superior | 95–98 | 0 | 0 | 0 | 0 |
| Very Superior | ≤ 99 | 0 | 0 | 0 | 0 |
| Total | | 34 | 100 | 34 | 100 |
| Mathematic Word Problem Subtest | | | | | |
| Very Poor | ≥ 1 | 8 | 24 | 7 | 21 |
| Poor | 2–5 | 7 | 21 | 7 | 21 |
| Below Average | 9–16 | 12 | 35 | 12 | 35 |
| Average | 25–75 | 7 | 21 | 8 | 24 |
| Above Average | 84–91 | 0 | 0 | 0 | 0 |
| Superior | 95–98 | 0 | 0 | 0 | 0 |
| Very Superior | ≤ 99 | 0 | 0 | 0 | 0 |
| Total | | 34 | 100 | 34 | 100 |
| Attitudes Toward Math Subtest | | | | | |
| Very Poor | ≥ 1 | 0 | 0 | 0 | 0 |
| Poor | 2–5 | 0 | 0 | 0 | 0 |
| Below Average | 9–16 | 3 | 9 | 0 | 0 |
| Average | 25–75 | 22 | 65 | 3 | 9 |
| Above Average | 84–91 | 5 | 15 | 22 | 65 |
| Superior | 95–98 | 4 | 12 | 5 | 15 |
| Very Superior | ≤ 99 | 0 | 0 | 4 | 12 |
| Total | | 34 | 100 | 34 | 100 |

*Note.* Scaled scores are calculated based on age. For this table, categories using raw scores are determined as if all students were the typical age for a Grade 7 student (13). Percentage totals may not equal 100% due to rounding equivalent scores.

Given that participants represented a wide age range (13–16 years of age) but were all seventh-grade students, the researcher determined that raw scores provided a more accurate representation for comparison than scaled scores (which change based on age). Hereafter, raw scores are used in descriptive statistics and statistical tests.

For example, many of the students performed in the average range (41% scaled scores, 47% raw scores) on the computation subtest. In contrast, only 3% of students performed in the above average range on the computation test. On the mathematics word problems subtest, 35% of students performed in the below average range and 21% performed in the poor range. On the math attitudes subtest, the majority of students' raw scores placed them in the above average (65%), superior (15%), or very superior range (12%), indicating high positivity in attitudes.

*Descriptive Statistics*

Before conducting the non-parametric tests, the researcher generated descriptive information including measures of central tendency, variability, and frequency tables. The researcher used SPSS to provide descriptive statistics and analyze the quantitative data. All participants were African American seventh grade students attending an urban middle school in southeast Texas who come from a low-socioeconomic environment and speak African American vernacular. Only students who attended the on-campus classroom environment for the 2020–2021 school year were included.

Demographic characteristics that differed among participants included gender and age (see Table 6). Most participants were males (65%, $n = 22$), and 35% of participants were female ($n = 12$). Half of the participants were 13 years of age (50%, $n = 17$) and 30% ($n = 10$) were 14. The researcher assumes 15-year-old (18%, $n = 17$) and 16-year-old participants (3%, $n = 1$) either repeated a grade level or were held back due to parent or administrative decisions.

Table 6

*Demographics: African American Participants' Age and Gender*

| | Gender | | | | | |
|---|---|---|---|---|---|---|
| | Male | | Female | | Total | |
| Age | % | *N* | % | *N* | % | *N* |
| 13 | 38 | 13 | 12 | 4 | 50 | 17 |
| 14 | 18 | 6 | 12 | 4 | 29 | 10 |
| 15 | 9 | 3 | 9 | 3 | 18 | 6 |
| 16 | 0 | 0 | 3 | 1 | 3 | 1 |
| Total | 65 | 22 | 36 | 12 | 100 | 34 |

*Notes.* All participants were in Grade 7. Percentage totals may not equal 100% due to rounding.

All 34 participants took the attitudes, computations, and mathematics word problems TOMA-3 subtests on April 19, 2021 (see Table 7).

Table 7

*Descriptive Statistics for Participants'* ($N = 34$) *Computations, Word Problems, and Attitudes Raw Scores*

| TOMA-3 Subtest | M | Median | *SD* | Minimum | Maximum | Range |
|---|---|---|---|---|---|---|
| Computations | 15.7 | 16 | 5.1 | 4 | 25 | 21 |
| Word Problems | 7.4 | 7.5 | 4.4 | 0 | 17 | 17 |
| Math Attitudes | 42.4 | 41.5 | 8.0 | 28 | 58 | 30 |

The average raw scores for computations (*M* = 15.7, *SD* = 5.1) were higher than their average raw scores for mathematics word problems (*M* = 7.4, *SD* = 4.4); however, both the students' computation and math word problems mean scores fell within the below average range for 13-year-old students.

Four students did not get a single question correct on the word problems subtest. (Appendix F presents scores by individual participant). Thirteen-year-old participants scored an average of 16.6 (*SD* = 5) on computations and 7.6 (*SD* = 4.9) on mathematics word problems. However, participants who were 14–16-years-old only averaged 14.9 (*SD* = 5.2) on computation and 7.2 (*SD* = 3.9) on mathematics word problems (see Table 8).

Table 8

*Participants' Subtest Raw Scores by Age (13 vs. 14–16 years)*

| TOMA-3 Subtest | 13-year-old participants | | 14–16-year-old participants | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| Computations | 16.6 | 5.0 | 14.9 | 5.2 |
| Word Problems | 7.6 | 4.9 | 7.2 | 3.9 |
| Attitudes | 42.6 | 7.2 | 42.2 | 8.7 |

The average raw scores for math attitudes (*M* = 42.4, *SD* = 8.0) indicate that regardless of lower scores with computations and mathematics word problems, participant attitudes toward math and their perceptions of their math abilities and achievement were highly positive (see Table 7). Aside from the 9% (*n* = 3) who had average math attitudes, student raw math attitudes scores ranged from above average (50%, $n = 17$) to very superior (12%, $n = 4$; see Table 5).

*Assumptions*

Researchers must investigate to see if data meets the assumptions for each statistical analysis they plan to use. Violations of statistical assumptions may prevent the researcher from making correct conclusions from the analysis because violations of assumptions bias results (Field, 2018). Linearity, equality of variance, and normality are the most common assumptions in statistics (Field, 2018). Normality assumes normal distribution with continuous variables, which are symmetric around the center. Assumptions are requirements that must be met before the researcher conducts a statistical analysis, which determines if conclusions are valid from the results of the data analysis process.

The researcher intended to perform a dependent or paired samples *t*-test to answer RQ1. For the researcher to conduct a paired sample *t*-test, the data need to be continuous, meet the assumption of normality of differences in scores, and have no outliers in the differences of scores (Kent State, 2021). In investigating the assumptions of normality of differences between computation and word problem scores, the data revealed the assumption of normality of differences was not met according to the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality, the histogram, the Q-Q plot, and the box plot (see Appendix G for output used to investigate assumptions). Therefore, the researcher used a nonparametric test similar to the dependent *t*-test, a Wilcoxon signed-rank test (Field, 2018).

Next, the researcher had to investigate the assumptions for Pearson's *r* correlation. The Pearson's *r* correlation required the use of a bivariate continuous data, linearity, normality, and the absence of outliers (Field, 2018). In investigating the assumptions of normality in scores for all three tests on the TOMA-3, the data revealed that the assumption of normality was met according to the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality, the histograms, and the box plots. Appendix H provides the output used to investigative assumptions for Pearson's *r* correlation. Therefore, there was no need for a non-parametric correlation, and the researcher concluded that all the sample scores come from normally distributed data, which gives the data reliability (Fields, 2018).

*Wilcoxon Signed-rank Test Results: Is there a Significant Difference in Computations and Word Problem Scores?*

As the data failed to meet assumptions to use the dependent *t*-test, the researcher used a nonparametric Wilcoxon signed-rank test to examine if significant differences existed between math computations and math subtest scores. On average, participants earned significantly higher raw math computations scores ($Mdn$ = 16) than the raw mathematics word problems scores ($Mdn$ = 7.5) based on the Wilcoxon signed-rank test, $T$ = -5.095, $p < .001$, $r$ = .62 (see Table 9).

In addition to investigating statistical significance using the Wilcoxon signed-rank test, the researcher reported an effect size. Effect sizes are used to demonstrate practical significance of the standardized magnitude of the difference between computations and mathematics word raw subtest scores. According to Field (2018), the appropriate effect size for a Wilcoxon signed-rank test results is reported below:

$$r = \frac{Z}{\sqrt{N}} \qquad r = \frac{-5.095}{\sqrt{68}}$$

The computation for effect size, *r*, is the *z* of -5.095 divided by the square root of 68 observations. The resulting effect size ($r$ = .62) shows a large difference as it above Cohen's benchmark of .5, a large effect (Cohen, 1988, 1992).

Table 9

*Related-Samples Wilcoxon Signed-rank Test Summary*

| Samples Wilcoxon Signed-rank Test | Summary |
|---|---|
| Total *N* | 34 |
| Test Statistic | .000 |
| Standard Error | 58.386 |
| Standardized Test Statistic | -5.095 |
| Asymptotic Sig. (2-sided test) | .000 |

*Pearson's r Correlation Results: Do Attitudes Towards Math Correlate with Math Performance?*

To examine correlations between math performance, math attitudes, and math self-perceptions, the researcher used Pearson's *r* correlation coefficient. See Table 10 for Pearson's *r* correlation results. Given the Pearson's *r* correlations, there was a small but nonsignificant relationship between student attitudes section of the TOMA-3 test and raw computations subtest scores ($r$ = .254, 95% CI [-.024, .515], $p$ =.147). Squaring Pearson's *r* represents the proportion of variance ($R^2$ = .065) in the math attitudes shared with raw computation scores. Figure 15 presents the scatterplot representing the relationship between math attitudes and raw computation subtest scores.

When determining the correlation between student attitudes towards mathematics and raw scores on the mathematics word problems section of the TOMA-3 test, Pearson's $r$ correlation ($r$ = .403, 95% CI [.106, .670], $p$ = .018) indicated there was a moderate, significant relationship between the two variables (see Table 10).

Table 10

*Pearson's r Correlation for Raw Subtest Scores*

| Toma-3 Subtest | Computations | Mathematics Word Problems | Attitudes About Math |
|---|---|---|---|
| Computations | | | |
| Pearson's *r* | | .662** | .254 |
| Significance, *p* | 1 | .000 | .147 |
| 95% Confidence Interval | | [.374, .877] | [-.024, .515] |
| Mathematic Word Problems | | | |
| Pearson's *r* | .662** | | .403 |
| Significance, *p* | .000 | 1 | .018 |
| 95% Confidence Interval | [.374, .877] | | [.106, .670] |
| Attitudes About Math | | | |
| Pearson's *r* | .254 | .403 | |
| Significance, *p* | .147 | .018 | 1 |
| 95% Confidence Interval | [-.024, .515] | [.106, .670] | |

*Note*. **Correlation is significant at the .001 level (2-tailed).

Squaring Pearson's $r$ ($R^2$ = .162) represents the proportion of variance in the outcome for attitudes shared with a predictor variable for raw word problem scores.

When converted to a percentage, both attitudes and raw mathematics word problem scores share a 16.2% of variance. Figure 16 presents the scatterplot representing the relationship between math attitudes and raw word problem subtest scores.

The Pearson's *r* correlation between raw scores for computations and raw scores for mathematics word problems ($r$ = .662, 95% CI [.374, .877], $p$ < .001) indicated there was a large, significant relationship between the two variables (see Table 10). Squaring Pearson's *r* ($R^2$ = .438) represents the proportion of shared variance in the between raw computation and raw word problem scores. When converted to a percentage, $R^2$ scores share a 43.8% of variance, which is a medium effect size. Figure 17 presents the scatterplot representing the relationship between raw math word problems and raw computation subtest scores.

The researcher chose four participants who had the largest difference between raw computations and mathematics word problems scores to understand why students performed better in the computations in comparison to the word problems (see Table 7). The participants who had the three highest difference in raw scores between computations and mathematics word problems were outliers in the data (as shown in Figure 2), which is why the researcher chose to interview them. Specifically, the four case numbers that had the highest difference in raw scores between computations and mathematics word problems were Participants 25, 11, 21, and 23 (see Tables 11, and 12). Table 11 also presents the five students with the highest difference in scores and the five students with the lowest difference in scores.

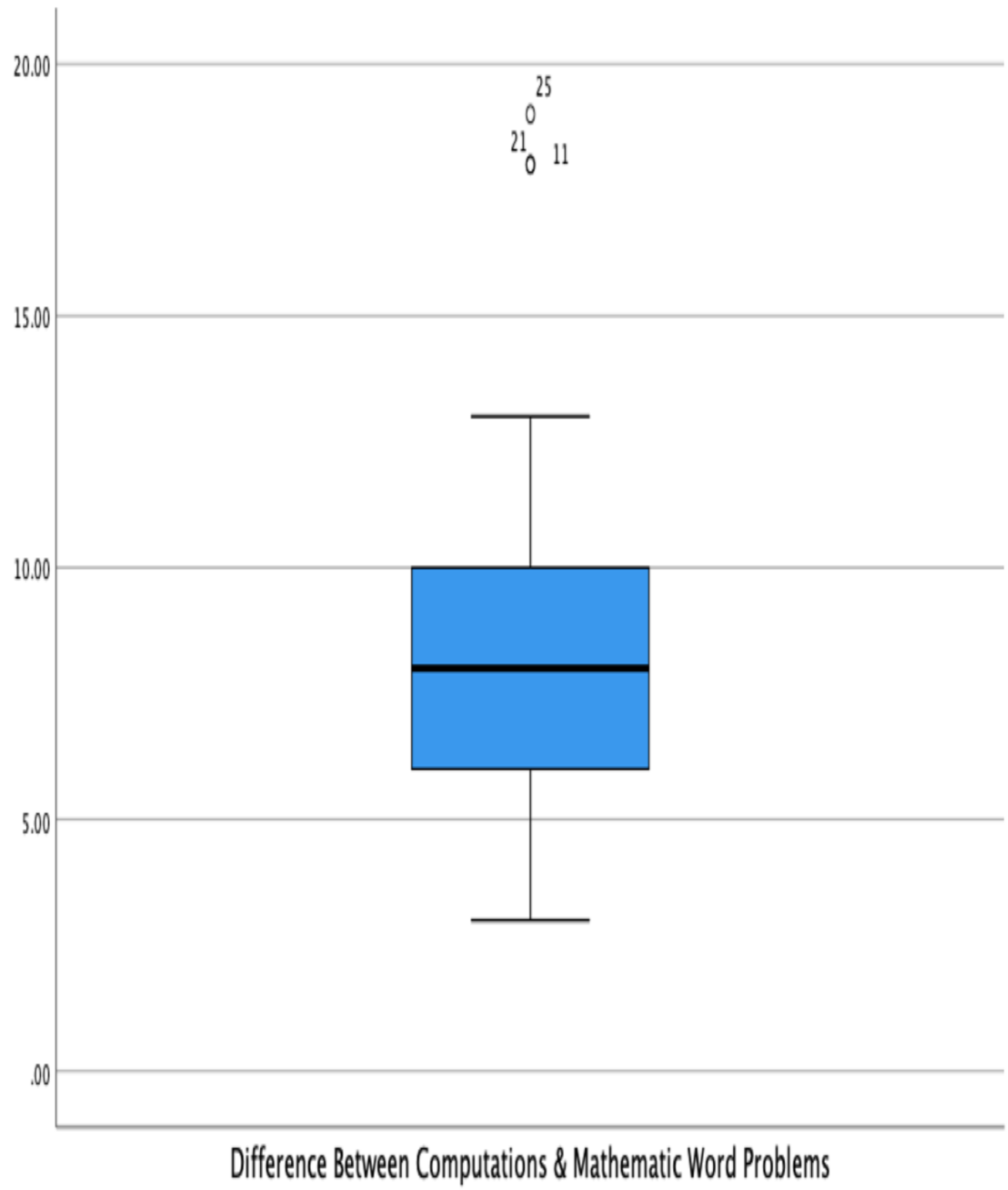



*Figure 2.* Outliers in difference between computations and mathematics word problems.

Table 11

*Extreme Values for Differences Between Computation and Word Problem Scores*

| Difference Between Computations & Mathematics Word Problems | | Case Number | Difference |
|---|---|---|---|
| | 1* | 25 | 19 |
| | 2* | 11 | 18 |
| Highest | 3* | 21 | 18 |
| | 4 | 23 | 13 |
| | 5 | 18 | 12 |
| | 1 | 29 | 3 |
| | 2 | 10 | 3 |
| Lowest | 3 | 5 | 3 |
| | 4 | 9 | 4 |
| | 5 | 32 | 5 |

*Note.* *Indicates outliers for differences of scores.

*Quantitative Results Used to Determine Qualitative Sample*

The sample used in the second phase of the study included four students selected from the original quantitative sample of 34 seventh-grade African American students who completed the TOMA-3 (V. L. Brown et al., 2013) instrument. The qualitative data were collected from students who had the largest difference in raw scores between computations and word problems on the TOMA-3 instrument (see Table 12).

Table 12

*Interview Participants' TOMA-3 Subtest Results*

| Pseudonym | Participant No. | Age | Attitudes Raw Score | Computations Raw Score | Word Problems Raw Score |
|---|---|---|---|---|---|
| | | | & Descriptive Term | | |
| Xavier | 25 | 13 | 43 | 19 | 0 |
| | | | Average | Average | Very Poor |
| Joan | 23 | 16 | 53 | 24 | 11 |
| | | | Above Average | Average | Below Average |
| Kara | 21 | 14 | 39 | 23 | 5 |
| | | | Average | Average | Poor |
| Matt | 11 | 13 | 28 | 18 | 0 |
| | | | Below Average | Average | Very Poor |

*Qualitative Data Findings*

The researcher asked a second research question, "What contributed to African American middle school students' performance between math computations in comparison to word problems?" In this section, the researcher discusses the findings of the qualitative results. In this phase of the research, a thematic analysis was conducted utilizing data collected through participant interviews.

The researcher conducted semi-structured interviews to understand why students performed better in the computations section of the TOMA-3 (V. L. Brown et al., 2013).

Additionally, with these interviews the researcher sought to understand student thoughts regarding performing higher on math computations in comparison to math word problems.

*Xavier*

Xavier is 13 years old and has a confident attitude about the subject of mathematics. Xavier feels his confidence about mathematics is an 8 out of 10 when it comes to solving mathematics word problems. Xavier stated, “Sometimes I forget what strategies to use, which is frustrating.” Xavier did not answer any word problems during the 20-minute time frame as he mentioned, “Some problems are tricky.” Time was also an issue for Xavier as he expressed, “I wanted to get to harder questions, but I panic when on a timer.” When Xavier reviewed the questions again from the word problem section, he felt more confident in breaking them down because he did not feel the pressure of running out of time. Xavier stated, “I like organizing my information from the word problem into a real-life situation.” Xavier writes out all his strategies and key words in his notebook.

When reviewing the word problems section of the TOMA-3, Xavier recalled some of the struggles he faced. Problem #4 reads “Shemar had six trucks and 10 SUVs. He wanted to give away three of the trucks. How many trucks would he have left?” During the interview Xavier realized that he should have subtracted three from six. He said, “I know what a truck looks like but was not sure if it was an SUV or not.” Xavier stated, “I knew that Shemar “wanted” to give away trucks but did not give them away immediately.” Xavier explains, “This was a tricky question because of future tense present in the word problem.

Another question that was tricky for Xavier was, “Ashley plays video games on her TV. She also watches these TV shows: Hot Dogs, Wild Animals, and Jana Banana. How many TV shows does Ashley watch?” Xavier stated, “I enjoy solving math with just numbers because it’s like I don’t get confused in what to do.” When looking back, Xavier saw that she “also” watches these TV shows, which indicated there were shows before and did not know whether to keep the video games or take them out. Xavier mentioned, “I always second guess myself because I’m afraid of getting a wrong answer.”

When it came to computations, Xavier mentioned, “I always get around numbers because they are easier to solve and have lesser words.” He shared, “I did not understand the square root symbol or the exponent symbols, I need my notebook to help me remember.” Xavier said, “Adding and subtracting decimals are hard sometimes.” He also shared he enjoys speeding through problems with numbers because “they don’t take long.”

Overall, Xavier stated he enjoys mathematics, and it is one of his favorite subjects in school. He believes he does not have to do as much reading as other subjects, and he gets to have fun with numbers while learning or as he says, “You get to do more.” He feels as though his notebook would have been helpful to the word section but could not remember some of the strategies he learned in class.

*Joan*

Joan is 16 years old and has an above average attitude about the subject of mathematics. Joan is a student who is confident about solving word problems as Joan mentioned, “I begin to visualize the problem.” Joan believes that time can be a factor when there is not enough information in a word problem. Joan mentioned that she had more time in elementary to solve word problems than in the middle school because of the 65-minute bell schedule. Joan said, “I like to prepare myself way ahead before taking a test by taking notes in class.” Joan shared that she does not consider herself a textbook learner. Joan expressed that when solving mathematics word problems, she analyzed the words in the sentence before determining the correct operation to use. Mathematics has always been Joan’s favorite subject because the instructor explains the answer and then demonstrates a step-by-step process. Joan admitted she gets frustrated when the instructor demonstrates problems because it does not give time for independent practice. Joan shared some self-discovery when stating, “I’m always ready to do the word problem by myself, but by the time we get to the end of class, I forget because there was not enough independent practice time in class.”

Joan’s mathematics performance in computations was higher than her performance in word problems. Although Joan scored below average in the word problem section, Joan remained confident in her abilities. Joan recalled working on problem #4 in the word problem section where she had a hard time determining what to add. The word problem read, “Shemar had six trucks and 10 SUVs. He wanted to give away three of the trucks. How many trucks would he have left?” Joan recalled having a conversation with her brother about the difference between trucks and cars. She remembered her brother saying, “A truck has a tail, and a SUV has a cargo.” Joan views trucks and cars the same way because both vehicles can seat more than five people. Joan misunderstood the word problem due to her own definition and understandings of trucks, cars, and SUVs.

Joan is a learner who prefers to have visuals as an aid when solving mathematics word problems. Joan stated that she relies on her imagination to create a visual for solving the problem. Problem #5 from the TOMA-3 mathematics word problem section stated, “Emily is six years old. She is one year younger than Andrew. Ava is eight years old. She is one year older than Andrew. How old is Andrew?” When Joan encountered this problem, she began to identify the number of people. Joan implies, “I put all three people in front of me and give Ava and Emily their ages, which narrows down to Andrew.” Joan utilized the strategy of elimination and imagery to solve the problem. Joan expressed that she knows with more practice, she can become a better mathematician.

Joan has a more positive outlook on computations because she feels as though she can checklist without having to comprehend. Joan shared that numbers require operative solving. Joan stated, “Some problems I don’t remember the teacher covering this year.” Problem #18 in the computations asks for the square root of 25, which Joan thought was a weird division sign. Joan mentioned she likes to be prepared in advance for tests and remember the methods for solving without feeling stuck. Although there were problems that Joan did not understand, other problems required strategies as Joan mentioned, “The butterfly method or cross multiplying when solving for proportions is good for finding percent in problem #28 because it is a skill that we used all year long or keep flip change when dividing fractions in problem #27.” Joan mentioned, “I could have used the mathematics reference chart for problems that asked for the volume.”

Overall, Joan admitted that she did not feel prepared in taking the TOMA-3 because there were no notes or practice before hand. She stated, “I get myself ready by reviewing everything and try to remember as much as I can." Joan believes showing all of her work is exhausting because you only have 5 minutes to do the "Do Now" and "Exit Ticket," which is not a normal time for accessing what a person knows. Joan continues to practice her mathematics skills and abilities to be prepared for any word problem.

*Kara*

Kara is 14 years old, and she has a confident attitude about mathematics, but feels sometimes she can forget the steps. When asked about the hardest math test that she had ever taken, Kara remembered taking an inequalities test and trying to figure out which symbol to use. Each answer had the same set of numbers, but with different symbols representing $<, >, \leq, \geq$. She stated that during the test, she could not remember. Kara mentioned another time where she converted fractions into decimals and got the answer wrong because she placed the decimal behind the wrong number. Kara expressed she always looks at key words in word problems first, then she looks at all the numbers, and then decides what operation the problem wants her to utilize. Kara said she likes to organize her thoughts during word problems and determine what she needs to eliminate to find her answer. Kara is competitive and does not like to get an answer incorrect.

When Kara reflected on the word problems section, she reviewed problem #4 which read "Shemar had six trucks and 10 SUVs. He wanted to give away three of the trucks. How many trucks would he have left?" Kara thought the trucks and the SUVs were all the same. She added them all together and then subtracted three when she realized she should have subtracted from just the trucks. Kara stated she felt as though she was rushing through problems because she wanted to answer as many as she could.

Kara disclosed she does not like to rush in class as she uses note taking strategies such as understand, plan, solve, and check (U.P.S check), where she sorts out all of her information.

Kara shared she sometimes struggles with word problems like #8 which read "Jennifer has two tickets for the big game. Today is January 2nd. The game is a week from today. What is the date on the tickets?" Kara put January the 14$^{th}$, but in the interview stated that she was thinking about the start of the second week in January since the 2nd is in the first week. Kara realized she could have counted 7 days from the 2nd, which would have been the 9th of January. She just noticed the phrase "A week from today" without understanding the specifics. Kara said she sometimes read problems fast because she feels as though she has to have a balance of time between solving word problems.

When it came to computations, Kara expressed she wanted to use a calculator because she feels she can check her work and solve numeric problems faster but understands that is not acceptable during testing. Kara recalled problem #23 in the computations section of the TOMA-3 which asked for the faces, vertices, and edges of a square. Kara mentioned that she did not remember parts of a three-dimensional square because it was taught at the beginning of the year, and she did not have her notes to help her. She knew that the faces rotate, which are the sides of the cube, but was confused between vertices and edges.

Regardless of the hurdles in mathematics, Kara feels there is nothing stopping her in mathematics. She knows with some numeric problems; she must remember steps and formulas. When it comes to word problems, she knows she must interpret the word problem before incorporating steps and formulas. Kara enjoys mathematics because she believes it will help her to go to college and in the real world.

*Matt*

Matt is 13 years old and does not feel confident about mathematics. Matt mentioned he feels halfway about his mathematics abilities because he has difficulty understanding word problems. He specifically talked about knowing the words and how to set up the word problem as a huge task. Matt says he sometimes has difficulty understanding certain vocabulary because he does not know their multiple meanings. Matt uses the butterfly method for finding proportions and the box method for multiplying when solving most problems. He organizes his problems by understanding where numbers go in equations when utilizing his notes. Matt uses a multiplication chart or a calculator to help him with complex numeric and word problems. Matt mentioned that he does not like to get wrong answers because it affects his grades.

When recalling problem #5, Matt had difficulty visualizing the ages of the three children. Problem #5 stated, "Emily is six years old. She is one year younger than Andrew. Ava is eight years old. She is one year older than Andrew. How old is Andrew?" Matt shared that he knew he had to add or subtract because of the "younger" and "older" that were in the word problem. Matt said that he had a hard time turning words into images without a teacher showing him how to break down these types of word problems. Matt admitted that sometimes he forgets what was taught in class when there are no notes to guide him.

Matt shared he struggled with the vocabulary when working on problem #4. Problem #4 stated, "Shemar had six trucks and 10 SUVs. He wanted to give away three of the trucks. How many trucks would he have left?" Matt wrote 10 -3. Matt shared that he had a hard time figuring out the vocabulary in word problems and was confused because he thought there were only SUVs. Matt recalled that when reading the word problem, he saw that 10 was a number in the first sentence and then proceeded without reading the "six" because it was in word format. Matt stated he must slow down when reading word problems but is eager to finish.

Although Matt did not get any of the word problems correct, he had a higher performance in the computations section of the TOMA-3. He indicated he knows when to multiply or divide and does not require his notes for computations. Matt did have a few computations that gave him a hard time, such as adding decimals when misaligned and remembering place value. However, he did remember the square root of 25 and the number of faces, vertices, and edges of a square.

Matt mentioned he did not remember exponents and finding missing degrees because his teacher briefly went over them. Matt feels teachers give too much work, and by the time he completed one problem, there are three more to solve. In addition, he feels as though there is too much writing when solving mathematics word problems. Matt stated he must work harder during class and work on mastering word problems as it is a survival skill.

### *Cross-Case Analysis*

Participants at the middle school in southeast Texas provided a more in-depth perspective on what contributed towards scoring higher on math computations in comparison to word problems. The semi-structured interviews included the experience of taking the TOMA-3 test, where participants expressed their experiences on both the math computations and word problems sections. Five critical findings related to the students' experiences with mathematics emerged from the interviews (see Table 13).

1. Feelings towards mathematics
2. Time being an issue
3. Vocabulary being an issue
4. Checkoff list for computations
5. Highly dependent on learning aids

*Xavier*

Xavier had a raw score of 19 "average" on the math computations section and a raw score of 0 "very poor "on the math word problem section (see Table 12). Although Xavier feels confident, he faced difficulty with solving mathematics word problems on the TOMA -3 test. When analyzing the data from Xavier's interview, he mentioned that some problems were tricky. For example, Xavier was confused about the vocabulary used when describing a truck and SUV. Xavier said that "I know what a truck looks like, but not sure if it is an SUV?" When working out the math computations section of the TOMA-3, Xavier expressed his attitude towards solving numeric problems, where his performance was 19, which is considered average. He mentioned that "Numbers are easier to get around and much faster to complete than word problems." Although Xavier had fun with the numbers, he still struggles with solving mathematics word problems. Another factor included time because Xavier has a difficult time-solving mathematics word problems when under pressure. He stated that "I want to solve the harder problems, but panic on a timer." Xavier takes notes during class and dependent on using them as guides when testing, which has helped him in the past.

*Joan*

Joan had a raw score of 24 “average” on the math computations and a raw score of 11 “below average “on the mathematics word problem section of the TOMA-3 test (see Table 12). Although Joan felt confident about her mathematics ability, she struggled with solving mathematics word problems. Time played a massive factor in Joan’s solving mathematics word problems when confronted with the vocabulary. When solving word problems, Joan struggled with distinguishing the truck and SUV in problem #4, as they seem the same to her. Joan prefers visuals when given problems related to comparison or other vocabularies that do not seem easy to understand. Even though Joan struggled with the mathematics word problems, she soared in the math computations section of the TOMA-3 test. Joan enjoys solving math problems that require operative thinking with sole numbers. She feels that soaring through the math computations is a checklist without having to comprehend vocabulary. Joan is more of a mental math solver than a note-taker, showing her desire for math computations rather than mathematics word problems.

Kara.

Kara is confident about her mathematic abilities, although she had a raw score of 23 “average” on the math computations section and a raw score of 5 “poor” on the mathematics word problem section of the TOMA-3 test (see Table 12). Kara struggled with vocabulary as she thought that the trucks and SUVs were in the same category from problem # 4 from the TOMA-3 test. Kara also had difficulty visualizing the calendar when solving another word problem that required figuring out the weeks due to no visual aids during the test. Although Kara was successful in the math computations section of the TOMA-3, she felt the need to use a calculator. Kara has a habit of reading mathematics problems fast, which gave her an advantage in the math computations section, but a disadvantage in the mathematics word problem section.

*Matt*

Matt did not feel confident about his mathematics, and he had a raw score of 18 “average” on the math computations section, which was higher than his raw score of 0 “very poor’ on the mathematics word problems section of the TOMA-3 (see Table 12). Although math computations had a positive outcome, Matt struggled with adding decimals when they were not aligned and sped through problems quickly, which was an issue in the mathematics word problems section. Vocabulary was an issue for Matt when it came to distinguishing vehicles. Matt thought those trucks were another version of SUVs, which was confusing. Matt has a hard time remembering strategies and relies on his notes to aid him. Matt is a speed reader and does not like to slow down, which makes it hard for him to solve word problems that are lengthy.

Table 13

*Cross-Case Interview Data*

| Theme | Xavier | Joan | Kara | Matt |
|---|---|---|---|---|
| Feelings towards mathematics | *X*<br>*Confident* | *X*<br>*Confident* | *X*<br>*Confident* | *X*<br>*Not Confident* |
| Time being an issue | *X* | *X* | | |
| Vocabulary being an issue | *X* | *X* | *X* | *X* |
| Checkoff list for computations | | *X* | *X* | *X* |
| Highly dependent on learning aids | *X* | *X* | *X* | *X* |

*Thematic Analysis*

Participants in the study provided insight into their performances between computations and word problems while expressing how they feel towards breaking down schematics of solving for the "situation." Thus, the second research question asks, "What has contributed to African American middle school students' performances between math computation in comparison to word problems?" The semi-structured interviews provided five crucial findings of African American student's beliefs about their experiences with seventh-grade computations and word problems in a low socioeconomic middle school in southeast Texas. The four findings along with student comments are in Table 14.

*Mixed Method Data Findings*

When analyzing the data, the researcher organized the findings from both the quantitative and qualitative results by using a joint display to compare results. There was a convergence of data when comparing participant feelings towards math computations and scores from the TOMA-3 (Table 15). The joint display represents the three categories tested from the TOMA-3 and a summary on how participants felt based on raw scores. The joint display also represents the participants feelings based on each category and how they align with summary from the TOMA-3 results.

Table 14

*Thematic Analysis Chart*

| Findings | Student Comments |
|---|---|
| Feelings towards mathematics | "Feel confident about mathematics"<br>"I always second guess myself because I'm afraid of getting a wrong answer."<br>"I like to prepare myself way ahead before taking a test by taking notes in class."<br>"Frustrated when I can't remember how to solve"<br>"I get myself ready by reviewing everything and try to remember as much as I can."<br>"Some problems I don't remember the teacher covering this year." |
| Time being an issue | "I wanted to get to harder questions, but I panic when on a timer."<br>"Not enough time on a test to solve word problems"<br>"Less time in middle school math class than elementary math class"<br>"Rushing through problems because of limited time"<br>"Some problems are tricky" |
| Vocabulary being an issue | "Don't understand some words"<br>"I know what a truck looks like but was not sure if it was an SUV or not."<br>"Solving problems with numbers is easier"<br>"Don't remember vertices, edges, and faces of a 3D cube |
| Checkoff list for computations | "I always get around numbers because they are easier to solve and have lesser words."<br>"I enjoy solving math with just numbers because it's like I don't get confused in what to do."<br>"Wish I could use a calculator to speed through numbers" |
| Highly dependent on learning aids | I like organizing my information from the word problem into a real-life situation."<br>"I could have used the mathematics reference chart for problems that asked for the volume."<br>"Need a notebook to remember strategies"<br>"Need a calendar to understand weeks and days in a month"<br>"Like to write all my information in a notebook" |

Table 15

*Joint Display of Seventh-Grade African American Student Experiences with TOMA-3 Instrument*

| Major Categories TOMA-3 & Results | Quantitative Results Summary | Exemplar Quote | Qualitative Results Summary | Mixed Methods meta-inferences |
|---|---|---|---|---|
| Math Computations<br><br>M (SD)<br>15.7 (5.1) | Computation skills are moderate | "Solving problems with numbers is easier"<br>"I always get around numbers because they are easier to solve and have lesser words."<br>"I enjoy solving math with just numbers because it's like I don't get confused in what to do." | Students felt confident in solving computations | Participants describe their experiences of solving computations, which is congruent to their results on the TOMA-3 instrument. |
| Mathematic Word Problems<br><br>M (SD)<br>7.4 (4.4) | Solving word problems are below average to poor | "Not enough time on a test to solve word problems"<br>"Rushing through problems because of limited time"<br>"Some problems are tricky"<br>"Don't understand some words"<br>"I know what a truck looks like but was not sure if it was an SUV or not." | Students did not feel confident in solving mathematics word problems | Participants describe their experiences with mathematics word problems as difficult, which is congruent with their results on the TOMA-3 instrument |
| Math Attitudes<br><br>M (SD)<br>42.4 (8.0) | Attitudes about mathematics was above average to superior | "I get myself ready by reviewing everything and try to remember as much as I can."<br>"Feel confident about mathematics"<br>"I like to prepare myself way ahead before taking a test by taking notes in class." | Students felt over-confident about their mathematics abilities | Although participants were overly confident, their scores were average and below, which is non-congruent to how they scored in both tests. |

When evaluating the key findings of the mixed methods data, there was a convergence of data when comparing participant feelings towards math computations and scores from the TOMA-3. There are various pieces of data that derived from both the quantitative and the qualitative results, which had some interesting correlations. There was congruency indicating that students were confident during the math computations section of the test. The convergence of data also implicated students' difficulty with vocabulary and misunderstandings with word problem resulted from low test scores in the mathematics word problem section of the TOMA-3. Students did not feel confident with solving mathematics word problems and expressed frustration. The math attitudes on the TOMA-3 were above average, although their feelings towards solving mathematics word problems differed. There was a convergence between students' perceptions in their abilities with mathematics on the math attitudes section with participant feelings during the interviews. There was a non-convergence between student feelings and mathematic scores, indicating that regardless of a high or low score, students enjoy the subject of mathematics.

### *Summary*

This explanatory sequential mixed methods study aimed to investigate the linguistic impact of mathematics word problems among African American students in the seventh grade. The researcher explored the feelings of African American students towards their performance in math computations, mathematics word problems, and math attitudes assessment using the Test of Mathematics Abilities, Third Edition (TOMA-3) instrument (V. L. Brown et al., 2013). In the following sections, the researcher elaborates on key findings, literature support, new findings not found in the literature, implications, limitations, and future recommendations for educators who struggle with increasing low mathematics scores with the African American population.

*Quantitative Key Findings*

When evaluating the key findings of the quantitative data, some interesting data surfaced. Overall, 50% of participants' raw scores were in the average or higher range (including 3% in the above average) in math computations. However, only 24% of participants scored in the average range, and none earned a higher score in the word problems. When conducting a Wilcoxon signed-ranked test to determine a difference between students' scores with math computations and mathematics word problems, a significant difference indicated a statistical significance. There is a large gap between students' math performance with numerical computations compared to their scores in mathematics word problems. Although there is a significance between math computations and mathematic word problems, there was a strong positive correlation between both tests ($r$ = .66), meaning in general that as one score increased, the other score increased.

Although there were low scores in math computations and mathematics word problems, participant attitudes toward math and their perceptions of their math abilities and achievement were highly positive. Based on the 34 participants, student raw math attitudes scores ranged from 9% with average math attitudes, 50% of the participants had an above-average attitude, and 12% felt very superior. The incongruence between perceptions and performance in mathematics is noteworthy. There was a moderate positive correlation between student math attitudes/abilities and their word problem score ($r$ = .40), but there was a statistically nonsignificant small correlation between the computation ability, their perceptions about math instruction and their abilities in mathematics ($r$ = .25). The data demonstrates a potentially small relationship between their computation abilities and math perspectives but demonstrates a stronger relationship between their math perceptions and their word problems.

About 50% of participants were 13 years of age, and 30% were 14 years of age. The other 20% of participants were between the ages of 15 and 16. The average age for students in the seventh-grade ranges from 11–13 years of age, which indicates that students may have repeated a grade level, started school late, or been held back a grade by parents or administrators. Students 13 years of age had an average˙ raw score of 16.6 on the math computations section and 7.6 on the mathematics word problems section. Students who were 14–16 years of age only averaged a raw score of 14.9 on the math computations and a raw score of 7.2 on the mathematics word problems, which was slightly lower than 13 years of age.

*Qualitative Key Findings*

When evaluating the key findings of the qualitative data, there were some surprising elements. Based on the interviews with the four participants, each person scored an average in math computations and below-average to very poor in mathematics word problems. The researcher chose four out of the 34 participants in the quantitative phase based on the largest difference between their word problems and their computation scores.

There was a 75% confidence level among participants regarding their perception of abilities in mathematics. Although participant perceptions of abilities in mathematics are high, students' feelings towards mathematics were the opposite. Participants felt frustrated when trying to solve, not able to prepare ahead of time, second-guessing themselves, and not remembering some of the math strategies for solving.

Participants mentioned that time was a factor in solving math word problems. Participants mentioned that they wanted to work on the more complex problems but panicked due to the time it took to interpret the language in each word problem. Some participants felt that they had to rush and that there was less time in middle school than elementary when solving word problems.

When determining the language in mathematics word problems, participants had difficulty interpreting vocabulary or symbols. For example, participants were unsure with words such as “SUV” and “Trucks,” which they believed had the same meaning, although they have different attributes. In addition, students did not understand vertices, edges, faces, square root symbols, or exponents with numeric word problems without their notebooks or learning aids.

Although participants did not understand some of the symbols in numeric word problems, they felt confident with the math computations of the TOMA-3. Participants felt that a checkoff list for math computations was more manageable when solving numeric word problems than vocabulary word problems. Some participants felt that they needed a calculator to speed through numbers in the sense of time.

Participants were highly dependent on learning aids, which were unavailable during the TOMA-3 test. Participants explained that they like organizing information from word problems using real-world situations. Some participants wanted a mathematics reference chart for finding volume, a mathematics notebook, or a calendar to help them with their mathematics.

*Results of Integration of Qualitative and Quantitative Data*

The first integration of the quantitative and qualitative data occurred when the researcher used the quantitative results to purposefully select participants for the qualitative stage. As the investigator was most interested in students with the greatest difference between their math computation scores and mathematics word problem scores, four participants with the greatest divergence were chosen. These participants were outliers out of the 34 participants in the TOMA-3, which informed a series of semi-structured interviews. Finally, the data analysis concluded with integrating the qualitative and quantitative results, demonstrating a convergence of data when comparing participant feelings towards math computations and mathematics word problems score from the TOMA-3. Congruency between participants' words and their scores indicated students' confidence during the math computations section of the test. The convergence of data also revealed students' difficulty with vocabulary and misunderstandings with word problems or negatively impacting test scores in the mathematics word problem section of the TOMA-3.

Students did not feel confident with solving mathematics word problems and expressed frustration. Most of all, the math attitudes on the TOMA-3 were above average, although their stated feelings towards solving mathematics word problems differed. There was a convergence between students' perceptions of their mathematics abilities on the math attitudes section of the TOMA-3 with participant feelings during the interviews. There was a non-convergence between student perceptions and mathematic scores, indicating that regardless of a high or low score, students enjoy the subject of mathematics.

*Discussion*

Mathematics in the United States has ranked the lowest among other diplomatic countries in the last nine years, as demonstrated through the data from PISA, NAEP, and TIMSS (Camera, 2019; Hiebert et al., 2003). When focusing on mathematics scores with subgroups, African Americans significantly score lower than their White counterparts and have the lowest scores across subgroups. In Texas, African American students score 50% lower than their non-minority peers on the Mathematics STAAR test (Texas Education Agency, 2019). The findings of this research study support these findings, as 50% of participants scored below average or lower in math computations and 75% scored below average or lower in mathematics word problems. The remaining participants' scores fell in the average range, with the exception of the lone individual who scored above average in math computations. Results also affirmed a need for understanding mathematics word problems due to the STAAR mathematics test content consisting of 65% readiness Texas Essential Knowledge and Skills that are mostly mathematics word problems, which require students to solve the "situation" by interpreting the mathematics jargon (Bailey, 2018; Jones, 2017).

Furthermore, the results indicate that African American youth from low-income homes scored higher in math computations than the mathematics word problem section on the TOMA-3. This was not due to the struggles with numeric problem solving but difficulties in vocabulary discernment. This study shows that math scores still reflect Powell's (2004) assertion that grade 6–8 minorities from low socioeconomic neighborhoods performed below academic standards. The results affirm a gap in literacy knowledge that is a barrier for raising math scores with African American students.

Mathematics word problems contain language and vocabulary, which differ from math computation problems. Participants expressed that they had difficulty interpreting the vocabulary in math word problems. Similar findings led the Unified School District to establish a task force that acknowledged a difference between Black children's language at home and standard English. Their findings identified this difference as the main root of low scores (Ogbu, 1999). The study indicated that students misunderstood mathematics language utilized in the word problems that concurred with the Unified School District task force with low scores. For example, participants found the words "SUV" and "Trucks" to have the same meanings, although both words have different characteristics in their descriptions. According to Smitherman and Geneva (2000) Ebonics can change the meaning of standardized English, such as the word "Off the hook," which means "Excited," and not "Out of trouble." This study further affirms a language gap among African American children due to unfamiliar terminologies found in mathematics word problem text.

Participants found themselves dependent on learning aids such as notebooks, calculators, calendars, and mathematics reference charts. Without the learning aids, the TOMA-3 was more difficult for participants due to feeling handicapped during testing. Learning aids include pictorial diagrams, written language, action movements, oral language, and mental images that guide cognitive problem-solving (Van Garderen, 2006, 2007; Van Garderen et al., 2013). According to Van Garderen et al. (2013) learning aids such as diagrams are a powerful component to solving math word problems. In addition, according to Farran et al. (2017), sequential learning materials give students a logical order to follow, which engages children in higher-order thinking, reflecting, planning, and problem-solving. Sequential learning materials can be helpful to students with mathematics problem-solving. However, school culture may have students too dependent on these aids as, and without them, the students felt that they underperformed on the TOMA-3.

The impact of timed tests was not originally included in the literature review, the researcher now recognizes the important role it plays in student performance. Participants revealed that time was an issue when working on mathematics word problems. Being on a timer caused panic because some participants took a while to comprehend the text and the word problems.

The findings revealed that there was overconfidence in math attitudes, which was not in the literature. Although African American students scored significantly lower in mathematics word problems than the math computations section of the TOMA-3, their attitudes remained positive. Participants felt more confident about their numeric abilities than their problem-solving abilities due to frustration with interpreting unfamiliar text and vocabulary. Overall, participants remained confident in their abilities, regardless of lower test scores with word problems.

### *Implications*

Findings from this study, indicate that the African American population continues to face barriers in solving math word problems and in achieving successful mathematics test scores. The implications are both practical and theoretical for educators who teach African American students in the context of mathematics in a low socioeconomic environment. The implications from the study can provide some insight to resolving this issue facing the African American population, which could change the course of the community in terms of mathematics achievement in school, careers, and in their daily lives.

Based on the mathematics word problem scores from the TOMA-3, participants scored the lowest in mathematics word problems than compared to math computations. In addition, participants felt that mathematics word problems gave them the most issues due to the math language and the vocabulary. Educators can implement vocabulary teaching strategies within the classroom setting that can help address unknown text or vocabulary. For example, educators can have students set up personal glossary pages in their math notebook where students write vocabulary definitions with corresponding examples. Additional vocabulary teaching strategies include working together with students on specific math terms by creating a graphic organizer for each term. Students can write the definition, use the term in an example, illustrate the word, and create a mathematics word problem sentence. When students miss certain words on a test, students can either write a simile or homophone, making note cards. While encountering complex text, teachers can have students access their math notebook and cards to play trivia games or have math talk about complex language found in word problems.

Another insight to participant performance is the factor of time. During testing students felt pressure and anxiety while trying to solve mathematics word problems. Tests are typically 30 to 45 minutes with 15 multi-step word problems, but the Texas STAAR mathematics test is four hours with 52 questions. Educators can implement stamina-building exercises and test-taking strategies during small groups or stations for educators to remedy the issue. Most students are keen on answering multiple-choice questions, where they can guess an answer and move on to the next problem. However, when it comes to short answers, essays, or multi-choice questions, students have difficulty determining strategies for breaking down a word problem. The TOMA-3 did not have multiple-choice, making it difficult to answer. Educators must address how to prepare students for high stakes testing with limited time barriers to eliminate the issues with mathematics word problems.

Students must learn the various strategies for specific test questions regardless of the format, multiple-choice, short answer, essay, open-ended response. During small group rotations in class, students can have stations where they learn the strategies for each testing format, such as short answers, essays, and open-ended responses where students must use more brainpower. Practicing these strategies without constantly guessing the multiple-choice answer can help build metacognition and confidence for future testing. Students' panic levels would decrease, and time would not be a factor due to learning strategies in class. The researcher also recommends that the U.S. moves away from the timed and accountability testing altogether. It produces anxious students that are dependent on learning aids and that are worried about high stakes test consequences.

A final recommendation is the implementation of culturally relevant education. As evidenced in the literature, there is a lack of culturally relevant education training for educators and test-writers. It is critical that educators learn to create environments that cater to the African American population. Culturally relevant education assists students with understanding the language of the curriculum and instruction. Unfortunately, some educators still believe in the "teach all in one" perspective, excluding specific subgroups such as African American students who do not benefit from this method. Culturally relevant education can bring awareness among educators who either ignore or do not know how to address the population.

### *Conclusion*

African American students continue to score the lowest among subgroups in mathematics, as other subgroups excel. While participants scored significantly lower in the mathematics word problem section of the TOMA-3, their attitudes towards mathematics remained high. Their lower performance was due to misunderstanding vocabulary and the inability to use learning aids during the TOMA-3 test. In addition, the pressure of a timed test and overconfidence in their mathematics abilities also played a crucial role in contributing to their mathematics performances. In addition, these findings can help remedy the barriers to African American students' performances with mathematics word problems. The following chapter discusses suggestions for expansion on future research with an executive summary, which includes the problem identification, overview of data collection, analysis procedures, summary of key findings, informed recommendations, and findings distribution.

# CHAPTER FIVE

## Distribution of Findings

### *Executive Summary*

There is a problem with the current instructional design for mathematics word problems that creates unique challenges for African American students. Both oral and written mathematics word problems are in standardized English, which can be problematic for African American students that primarily utilize AAVE. The mathematics text in word problems derives from an Anglocentric perspective that excludes African American students' ethnic, cultural, and linguistic needs (A. B. Powell, 2004). Standardized testing requires students to decipher the language of written word problems in mathematics, which also contains Anglocentric text (Apple, 1990).

African American student scores have decreased over the past decade, while their White counterparts have excelled in mathematics scores (Quintana & Mahgoub, 2016). African American students score the lowest in mathematics compared to other subgroups based on the National Assessment of Education (NAEP), The Trends in International Mathematics and Science Study (TIMSS), and Programme for International Student Assessment (PISA) reports (Camera, 2019). Mathematics scores for African American students on the STAAR mathematics for Grades 7–8 in 2019 was 33% for meeting state standards, while their White counterparts averaged 59% in reaching state standards (Texas Education Agency, 2019). Based on the Nations Report Card NAEP, African American students scored 27% below their White counterparts in mathematics. Research suggests redesigning mathematics word problems and the linguistic analogy is mandatory, regardless of the instructional model (Bailey, 2018).

### *Overview of the Data Collection and Analysis Procedures*

The study utilized an explanatory sequential mixed methods approach with three phases. The first phase was quantitative, where the researcher tested 34 African American students using the TOMA-3 (V. L. Brown et al., 2013) to determine if students scored higher in computations than mathematics word problems. Then the researcher chose four students out of the 34 to interview for the qualitative phase. The students chosen to be interviewed had the largest difference between computations and mathematics word problems on the TOMA-3. Finally, students were interviewed to understand what contributed to their performance. Then the researcher found themes with both the quantitative and qualitative findings to determine the final results. The researcher utilized an inductive thematic analysis and created a joint display table. The joint display table included qualitative results with raw scores from the quantitative results of the math computations, mathematics word problems, and math attitudes section of the TOMA-3 (V. L. Brown et al., 2012).

### *Summary of Key Findings*

The researcher administered the TOMA-3 test, consisting of math computations, mathematics word problems, and math attitudes, with 34 African American participants in the seventh grade. When observing the key findings for the quantitative analysis, 47% of participants scored an average in raw scores with the math computations section, where less than half of the participants made a raw score of 24% in mathematics word problems. However, their attitudes about mathematics achievement were above average.

About 50% of the participants were 13 years of age, and 30% were 14 years of age. Students 13 years of age had an average raw score of 16.6 on the math computations section and 7.6 on the mathematics word problems section. Students who were 14 -16 years of age only averaged a raw score of 14.9 on the math computations and a raw score of 7.2 on the mathematics word problems, which was slightly lower. When conducting a Wilcoxon signed-ranked test to determine a difference between students' scores with math computations and mathematics word problems, a significant difference indicated a statistical significance. There is a massive gap between math computations with numbers and language in mathematics word problems.

When analyzing the key findings for the qualitative results, the researcher chose four participants who were outliers with the most significant difference between math computations and mathematics word problems. All four participants scored an average in math computations, while mathematics word problems are below average to very poor. There was a 75% overall confidence with all participants. However, participants struggled with vocabulary during the mathematics word problems section of the TOMA-3. Participants revealed that time was also an issue when working on mathematics word problems. Being on a timer caused panic because some participants took a while to comprehend the text and in the word problems. Some participants disclosed that they viewed computations as a check off the list, meaning less comprehension of reading and more numeric language. Computations seem to have less complexity because there is less memory used when solving numeric problems than mathematics word problems, where the demands for memorizing strategies was higher. Participants found themselves dependent on learning aids such as notebooks, calculators, calendars, and mathematics reference charts. Without the learning aids, the TOMA-3 was more difficult for participants due to feeling handicapped during testing.

The researcher utilized a joint display table to organize the findings from the quantitative and the qualitative results. There was a convergence of data between the participant's feelings towards math computations and scores from the TOMA-3 test. The joint display represents the three categories tested from the TOMA-3 and a summary of how participants felt based on raw scores. The joint display also represents the participant's perspectives on each category and how they align with the summary from the TOMA-3 results. There were some interesting data correlations derived from the quantitative and the qualitative results. There was congruency indicating that students were confident during the math computations section of the test. The convergence of data also implicated that students' difficulty with vocabulary and misunderstandings with word problems, resulted in low test scores. Students did not feel confident with solving mathematics word problems and expressed frustration. Additionally, the math attitudes on the TOMA-3 were above average, although their feelings towards solving mathematics word problems differed. Finally, there was a non-convergence between student feelings and mathematics scores, indicating that regardless of a high or low score, students enjoy the subject of mathematics.

*Informed Recommendations*

Based on the findings from this explanatory sequential mixed methods study, there are recommendations for educators to help the middle school African American students who struggle with solving mathematics word problems. These recommendations could help remedy the problem with low mathematics scores, deciphering the language and vocabulary found in mathematics word problems.

One recommendation is implementing vocabulary teaching strategies such as having students set up personal glossary pages in their math notebook where students write the definition with corresponding examples. Vocabulary teaching strategies include working together with students on specific math terms by creating a graphic organizer for each term. Students can write the definition, use the term in an example, illustrate the word, and create a mathematics word problem sentence. When students miss certain words on a test, students can either write a simile or homophone, making note cards. While encountering complex text, teachers can have students access their math notebook and cards to play trivia games or have math talk about complex language found in word problems.

Another recommendation is building stamina for taking the test under timely pressure without students panicking or giving up. Students must learn the various strategies for specific test questions regardless of the format, multiple-choice, short answer, essay, open-ended response. During small group rotations in class, students can have stations where they learn the strategies for each testing format, such as short answers, essays, and open-ended responses where students must use more brainpower. Practicing these strategies without constantly guessing the multiple-choice answer can help build metacognition and confidence for future testing. In an ideal world, accountability timed testing would be eliminated. This would allow students to focus on and have the time to truly understand and solve mathematics word problems.

The final recommendation is implementing Professional CRE practices among teachers and staff. Professional CRE practices for teachers are crucial to the African American population due to the current lack of CRE practices in the classroom setting. CRE practices connect to all cultural aspects such as language, sexuality, class, and gender. Teachers should learn how to create a multicultural environment that connects both teachers and students during instruction. Through CRE teachers become more unaware of the cultural needs of African American students and assist in decreasing the barriers to learning and to achievement in mathematics.

### *Findings Distributions and Proposals*

The following section features the findings and distributions, through which the researcher plans to expand their work after graduation. Finally, the researcher mentions the target audience based on the findings and how they plan to build their audience using digital platforms.

*Target audience.* The target audience for these findings are school officials in the middle school setting, teachers, mathematicians, textbook publishers in mathematics, and the African American community. These various stakeholders need to understand the academic and cultural needs of African American students. These research findings are of interest to school officials in the middle school setting because many public schools share this issue and need to increase the mathematics scores for the African American student population. In addition, officials' careers rely on new data, which would benefit their school ratings from F to an A. Mathematicians would benefit from this research by building a curriculum and text that cater to the African American community's vocabulary. Similarly, these findings can contribute to mathematics textbook publishers, emphasizing the need to shift away from textbooks that root in Anglocentric perspectives that exclude African American language and culture. The research would help the African American community by developing tutoring or after-school programs that focus on vocabulary and text in word problems that are unknown in the household language. In addition, making the community aware of this issue can combat the misconceptions of word problems by making mathematics a priority for future careers. The most vital audience are teachers. Teachers work directly with students and would benefit from professional development and can work cohesively with community leaders to implement CRE practices suitable for African American students.

*Proposed Distribution Method and Venue*

The proposed distribution method of these findings is through the *African Diaspora Journal of Mathematics*. *The African Diaspora Journal of Mathematics* is an international mathematics publication that is ranked the highest for African American research and mathematics. In addition, the African Diaspora Journal of Mathematics has partnered with Project Euclid under the Mathematics Research Publishers (MRP). There is no formal application process, but publications must have appropriateness and quality. Technical requirements include choosing between hosting services only, hosting plus sales, marketing, hosting, and complete publishing services. An article proposal will be submitted to the publisher with aspirations for publication in December 2022 while also preparing a presentation for stakeholders for a potential mentoring program.

The researcher also plans to promote the research findings through a series of podcasts, Instagram, and YouTube venues discussing topics related to African American students' mathematic scores on STAAR, vocabulary strategies, and test-taking strategies for an essay or multiple-choice and open-ended questions. The podcast would be a weekly series where different educators from officials, teachers, mathematicians, textbook publishers in mathematics, and the African American community discuss the issues of mathematics word problems with African American students. The series would be twice a week and 45 minutes to an hour. The researcher would present different parts of his findings, such as feelings towards mathematics, misunderstanding of vocabulary or text, time, admiration for computations, and the use of learning aids.

The researcher will have guests email him with their background and credentials before allowing them to join the Zoom Chat. Then each guest can bring enrichment and knowledge to each topic. The podcast can help the African American community with a platform that serves our youth. The podcast would be uploaded to the Instagram page to attract subscribers. In addition, the podcast would promote notoriety and future book publishing. Starting a podcast is free due to being an Audio platform. When the podcast grows the Instagram channel with over 100,000 subscribers, the platform can receive funding through PodFund that helps successful small channels turn into a business with donations ranging from $25,000 to $150,000 for applicants. Then the researcher can start the YouTube channel, where a small couch, microphones, and décor can create a platform where previous podcasters come in person. I believe that the channels can be a voice for all educators in the future and researchers who want to discuss their findings.

*Distribution Materials*

The distribution materials would be presented in a podcast format through an Instagram platform online to promote the study's findings, promote the published dissertation, and enrich the study of mathematics with various stakeholders. In addition, the podcast will help enlighten others about discoveries with mathematics and highlight the issues with language, vocabulary, learning aids, and time. Educators from officials, teachers, mathematicians, textbook publishers in mathematics, and the African American community would join the podcast through a Zoom waiting room where each guest waits to speak on issues with mathematics in the African American community.

### *Conclusion*

The current instructional design for mathematics still poses a challenge for African American students. Specific issues include language, pressure induced from timed tests, overconfidence of mathematics abilities, dependence on learning aids, and the need for expanding student vocabulary. Creating a podcast that shares the research findings, the published dissertation, and mathematics is vital to helping African American youths who continue to score low in mathematics. In addition, advocating for African American students and the African American community can help minimize the gaps in mathematics and increase awareness.

APPENDICES

## APPENDIX A

Interview Questions Protocol

**Baylor University**
**Department of Education**

Institutions: ______________________________________________

Interviewee (Title and Name): _______________________________

Interviewer: _______________________________________________

Survey Section Used:

_____ A: Interview Background (History in working on word problems with formative, summative, and the STAAR mathematics)

_____ B: Vocabulary (Math terminologies- TOMA-3)

_____ C: Strategies (Hands on, visual or images, solving for the “situation” TOMA-3)

_____ D: Math Aides (Rely on calculator, math charts, and formulas TOMA-3)

_____ E: Written Language (Past and present tense, coordinating conjunctions, homophones, and synonyms TOMA-3)

_____ F: Mathematics self-concept (student rating skill, ability, enjoyment, interest, and attitudes in mathematics)

Other Topics Discussed: ______________________________________

__________________________________________________________

Documents Obtained: _________________________________________

__________________________________________________________

__________________________________________________________

Post Interview Comments or Leads:

__________________________________________________________

*Perceptions, Attitudes, and Assessment Interviews*

Introductory Protocol

*To facilitate our notetaking, we would like to use the Zoom chat recorder for our conversations today. Please sign the release form. For your information, only researchers on the project will be privy to the Zoom chat recording, which will be eventually destroyed after they are transcribed. In addition, you must sign a form devised to meet our human subject requirements. Essentially, this document states that: (1) all information will be held confidential, (2) your participation is voluntary, and you may stop at any time if you feel uncomfortable, and (3) we do not intend to inflict any harm. Thank you for your agreeing to participate.*

*We have planned this interview to last no longer than one hour. During this time, we have several questions that we would like to cover. If time begins to run short, it may be necessary to interrupt you in order to push ahead and complete this line of questioning.*

Introduction

You have been selected to speak with us today because you have been identified as someone who struggles to solve math word problems on this campus. Our research project as a whole focus on the improvement of helping African American youth's in mathematics, with particular interest in understanding how students use their minds when solving math word problems, how students perceive math word problems, and whether we can begin to share what we know about making a difference in math education. Our study does not aim to evaluate your techniques or experiences. Rather, we are trying to learn more about the barriers that hinder the thought process when solving math word problems and hopefully learn about student practices that help improve campus math scores.

**Interview Protocol**

Time of the Interview:
Date:
Place:
Interviewer:
Interviewee:

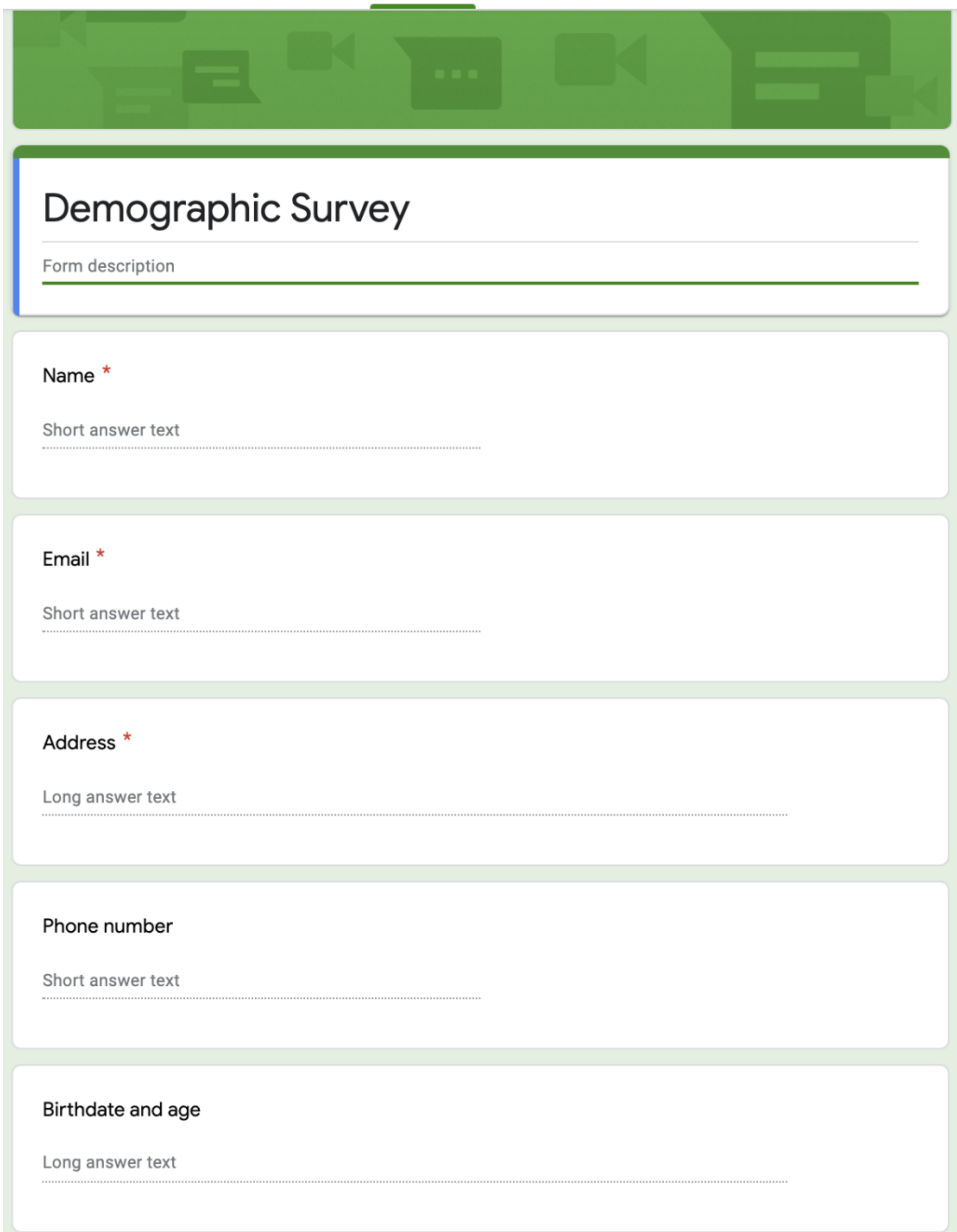
| Interview Question | Research Sub-Questions Addressed by Interview Question |
|---|---|
| Interview Background | |
| What is the most difficult test that you have taken in mathematics? (formative, summative, benchmarks, Math STAAR) | 2. What has contributed to African American middle school students' attitudes toward math and the differences in their performance between math computation and word problems? |
| Why do you find this particular test difficult? | 2. What has contributed to African American middle school students' attitudes toward math and the differences in their performance between math computation and word problems? |
| What is something that you notice with previous word problems that seem to be an obstacle when solving? | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |

| Vocabulary | |
|---|---|
| What particular words gave you a hard time in understanding the word problem and why? (use example from TOMA-3) | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| How would you interpret the word problem in your own words? (use examples from TOMA-3) | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| **Strategies** | |
| What strategy did you use to solve? (use examples from TOMA-3 | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| How did you organize your information? Your thinking? (use examples from TOMA-3) | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| How did you begin to think about this problem? (use examples from TOMA-3) | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| What is another way you could solve this problem? (use example from TOMA-3) | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| **Math Aides** | |
| What do you use for help when solving math word problems? | 2. What has contributed to African American middle school students' attitudes toward math and the differences in their performance between math computation and word problems? |
| What do you use to help you when you are unable to solve a math word problem right away? | 2. What has contributed to African American middle school students' attitudes toward math and the differences in their performance between math computation and word problems? |
| Was the TOMA-3 difficult without the use of math aides? | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |

| | |
|---|---|
| Are there words or sentences that do not make sense in this word problem? (use examples from TOMA-3) | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| What is the word problem asking you to do or can you tell me the parts that are unclear? (use examples from TOMA-3) | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| Did computations make sense with equating rational numbers? | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| Math Self-Concept | |
| What goes through your mind when you see mathematic problems | 2. What has contributed to African American middle school students' attitudes toward math and the differences in their performance between math computation and word problems? |
| What is an obstacle that has hindered you from understanding math word problems? | 2. What has contributed to African American middle school students' attitudes toward math and the differences in their performance between math computation and word problems? |
| Which section of the TOMA-3 was difficult? Computations or math word problems? Why? | 1. Do African American middle school students score significantly lower on the word problem compared to the computation section of the TOMA-3 and do their attitudes towards math correlate with their performance? |
| What do you believe is the problem with math test and word problems? | 2. What has contributed to African American middle school students' attitudes toward math and the differences in their performance between math computation and word problems? |
| How confident are you in your mathematics abilities? | 2. What has contributed to African American middle school students' attitudes toward math and the differences in their performance between math computation and word problems? |
| Third Research Question | |
| *I can only answer my mix method question after collecting data. → | 3. How do the themes that emerged from the interview with African American middle school students about math attitudes and solving word problems help explain the quantitative math attitude, computation, and word problem scores? |

APPENDIX B

Google Survey Form



# Demographic Survey

Form description

Name *

Short answer text

Email *

Short answer text

Address *

Long answer text

Phone number

Short answer text

Birthdate and age

Long answer text

Do you speak Ebonics or Slang at home (Black Talk)

Short answer text

Sex

Suggestions: Prefer not to say

- Male
- Female

What was your score on the STAAR Mathematics test?

Short answer text

Do you receive free lunch at school?

Short answer text

APPENDIX C

Parent Consent Form

**Baylor University**
**Department of Education**

Parent Consent Form for Research

PROTOCOL TITLE: An Explanatory Sequential Mixed Methods with Solving Mathematics Word Problems Among African American Students

PRINCIPAL INVESTIGATOR: Patrick Hughes

Your child is invited to be part of a research study. This consent form will help you choose whether or not to let your child participate in the study. Feel free to ask if anything is not clear in this consent form.

Things you should know:

- The purpose of the study is to learn more about how the language of mathematics affect African American students when solving word problems.
- In order to participate, your child must be in 7th grade, age 11-16, African American descent, have difficulty with solving math word problems and come from a low-income household.
- If you choose to allow your child to participate, your child will be asked to Take a Test of Mathematics Abilities for 40 min – one in math word problems for 20 min and one in computations for 20 min. This will take about 1 hours. Then 4 participants from that group will be asked to do a recorded Zoom chat interview about questions from the Test of Mathematics Abilities and how they feel about math word problems. (1 Day for 45 minutes with each participant)
- The possible benefits of this study will help the researcher to understand the language barriers that African American youth's experience when reading math word problems and help the understanding low math scores.
- Taking part in this research study is voluntary. You do not have to allow your child to participate, and you can stop your child's participation at any time.

More detailed information may be described later in this form. Please take time to read this entire form and ask questions before deciding whether to allow your child to take part in this research study. The purpose of this study is to learn more about how the language of mathematics affects African American students when solving word problems. We are asking you join this study because it can help educators create cultural trainings to help teachers in assisting the African American population in mathematics and closing the achievement gap**.**

If you agree to allow your child to take part in this study, your child will be asked to:

The activities within the study include:

- 30 participants taking a Test of Mathematics Abilities (1 Day for 1 hour) @[redacted]
    - 20 minutes for math word problems
    - 20 minutes for computations
    - 20 minutes for math attitudes
- Then 4 participants from that group will be asked to do a recorded Zoom chat interview about questions from the Test of Mathematics Abilities and how they feel about math word problems. (1 Day for 45 minutes with each participant) @ Virtual Online
- If you do not want to be recorded, you should not be in this study.

This study will take 3 hours, and there will be 34 participants in this study. This study will interview 4 participants from a group of 34, which will take 45 minutes as each participant is interviewed each day. This study will take place in the Spring of 2021 between January -Mid-March. Participant identities will be hidden, and the Zoom Chat recording is only for research purposes. Once the data from the interviews are collected, the recording will be deleted. This study will help me to understand the language barriers that African American youth's experience when reading math word problems and help the researcher in understanding low math scores.

A risk of taking part in this study is the possibility of a loss of confidentiality. Loss of confidentiality includes having your child's personal information shared with someone who is not on the study team and was not supposed to see or know about your child's information. The researcher plans to protect your child's confidentiality.

We will keep the records of this study confidential by not sharing their name, address, school, or grades from the test. We will make every effort to keep your child's records confidential. However, there are times when federal or state law requires the disclosure of your child's records.

The following people or groups may review your child's study records for purposes such as quality control or safety:

- Representatives of Baylor University and the BU Institutional Review Board
- Other collaborating organizations such as Spring ISD.
- Federal and state agencies that oversee or review research (such as the HHS Office of Human Research Protection or the Food and Drug Administration)

Participants will get the hot chips of their choice, the large chocolate bars of their choice with a Capri Sun during the testing day. The four participants chosen for interviews will get a $25 gift card from Amazon.
The researcher may take your child out of this study without your permission. This may happen because:

- The researcher thinks it is in your child's best interest
- Your child can't make the required study visits
- Other administrative reasons

Allowing your child to take part in this study is your choice. You are free not to allow your child to take part or to withdraw your child at any time for any reason. No matter what you decide, there will be no penalty or loss of benefit to which you or your child are entitled. If you decide to withdraw your child from this study, the information that your child has already provided will be kept confidential. You cannot withdraw information collected prior to your child's withdrawal.

You can ask any questions at any time. You can ask now or later. Just tell the researcher when you see them, or ask your parent or another adult to contact:

Patrick Hughes, Ed.D. Student at Baylor University
Phone: [redacted]
Email: [redacted]@baylor.edu

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the following:

Baylor University Institutional Review Board
Office of the Vice Provost for Research
Phone: 254-710-3708
Email: irb@baylor.edu

Name of child (please print):

____________________________________________

By signing this document, you are agreeing to your child's participation in this study. Make sure you understand what the study is about before you sign. We will give you a copy of this document for your records. We will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

*I understand what the study is about and my questions so far have been answered. I agree for my child to take part in this study.*

__________________________________ __________________
Signature of Parent/Guardian Date

___________________________________ ___________________

Signature of Parent/Guardian Date

I have explained the research to the subject and answered all his/her questions. I will give a copy of the signed consent form to the subject.

_____________________________________ _____________________

Signature of Person Obtaining Consent Date

APPENDIX D

Assent Form

**Baylor University**
**Department of Education**

Assent Form for Research

PROTOCOL TITLE: An Explanatory Sequential Mixed Methods with Solving Mathematics Word Problems Among African American Students

PRINCIPAL INVESTIGATOR: Patrick Hughes

We want to tell you about a research study we are doing. Research studies help us to learn new things and test new ideas. People who work on research studies are called researchers. During research studies, the researchers collect a lot of information so that they can learn more about something.

We are doing this study because we would like to learn more about how the language of mathematics affects African American students when solving word problems. We are asking you join this study because it can help educators create cultural trainings to help teachers in assisting the African American population in mathematics and closing the achievement gap**.**

The activities within the study include:

- 30 participants taking a Test of Mathematics Abilities (1 Day for 3 hours) @[redacted]
  - 20 minutes for math word problems
  - 20 minutes for computations
- Then 4 participants from that group will be asked to do a recorded Zoom chat interview about questions from the Test of Mathematics Abilities and how they feel about math word problems. (1 Day for 45 minutes with each participant) @ Virtual Online
- If you do not want to be recorded, you should not be in this study.

This study will take 3 hours, and there will be 34 participants in this study. This study will interview 4 participants from a group of 34, which will take 45 minutes as each participant is interviewed each day. This study will take place in the Spring of 2021 between January -Mid-March. Participant identities will be hidden, and the Zoom chat recording is only for research purposes. Once the data from the interviews are collected, the recording will be deleted. This study will help me to understand the language barriers that African American youth's experience when reading math word problems and help the researcher in understanding low math scores.

You do not have to be in this study. It is up to you. You can say "yes" now and change your mind later. No one will be upset if you do not want to do this. All you have to do is tell us you want to stop. We will limit the use of your information that we collect to people who have a need to review this information. We cannot promise to keep everything a secret, but we will work to keep your name and other information private. Your responses may be used for a future study by us or we may share your responses with other researchers.

Participants will get the hot chips of their choice, the large chocolate bars of their choice with a Capri Sun during the testing day. The four participants chosen for interviews will get a $25 gift card from Amazon.

You can ask any questions at any time. You can ask now or later. Just tell the researcher when you see them, or ask your parent or another adult to contact:

Patrick Hughes, Ed.D. Student at Baylor University
Phone: 346-XXX-XXXX
Email: XXX@baylor.edu

**Statement of Assent**

If you want to be in the study, write your name below.

______________________________________ ______________________
**Signature of Subject** **Date**

APPENDIX E

Baylor IRB Approval Letter

Baylor University

INSTITUTIONAL REVIEW BOARD – PROTECTION OF HUMAN SUBJECTS IN RESEARCH

**NOTICE OF EXEMPTION FROM IRB REVIEW**

| | |
|---|---|
| Principal Investigator: | Patrick Hughes |
| Study Title: | An Explanatory Sequential Mixed-Methods with Solving Mathematical Word Problems Among African American Students |
| IRB Reference #: | 1685679 |
| Date of Determination: | December 15, 2020 |
| Exemption Category: | 45 CFR 46.104(d)(1) |

The above referenced human subjects research project has been determined to be EXEMPT from review by the Baylor University Institutional Review Board (IRB) according to federal regulation 45 CFR 46.104(d)(1): Research conducted in established or commonly accepted educational settings, involving normal educational practices.

The following documents were reviewed:

- IRB Application, submitted on 12/15/2020
- Protocol Version 1, dated 12/08/2020
- Assent Form, submitted on 12/14/2020
- Parent Permission Form, submitted on 12/15/2020
- TOMA-3 Instrument Survey, submitted on 11/22/2020
- TOMA-3 Survey Protocol, submitted on 11/22/2020
- Interview Questions, submitted on 11/22/2020

This exemption is limited to the activities described in the submitted materials. If the research is modified, you must contact this office to determine whether your research is still eligible for exemption prior to implementing the modifications.

If you have any questions, please contact the office at (254) 710-3708 or IRB@baylor.edu

Sincerely,

[redacted]

Deborah L. Holland, JD, MPH, CHRC, CHPC
Assistant Vice Provost for Research, Research Compliance

OFFICE OF THE VICE PROVOST FOR RESEARCH | RESEARCH COMPLIANCE

APPENDIX F

Individual Participant Raw and Scaled Scores

Table 16

*Individual Participant Raw Scores and Scaled Categorial Score Ordered by Age*

| # | Sex | Age | Comp. Raw | Computation Scaled Score Category | W.P. Raw | Word Problem Scaled Category | Att. Raw | Math Attitudes Scaled Score Category |
|---|---|---|---|---|---|---|---|---|
| 13 | Male | 13 | 5 | Very Poor | 0 | Very Poor | 42 | Average |
| 16 | Male | 13 | 10 | Poor | 3 | Very Poor | 42 | Average |
| 28 | Male | 13 | 12 | Poor | 6 | Poor | 38 | Average |
| 10 | Male | 13 | 12 | Poor | 9 | Below Average | 49 | Above Average |
| 8 | Female | 13 | 14 | Below Average | 5 | Poor | 40 | Average |
| 30 | Male | 13 | 15 | Below Average | 7 | Below Average | 47 | Average |
| 20 | Male | 13 | 17 | Average | 9 | Below Average | 30 | Below Average |
| 7 | Female | 13 | 17 | Average | 7 | Below Average | 46 | Average |
| 14 | Female | 13 | 17 | Average | 9 | Below Average | 50 | Above Average |
| *11 | Male | 13 | 18 | Average | 0 | Very Poor | 28 | Below Average |
| 31 | Male | 13 | 18 | Average | 10 | Below Average | 42 | Average |
| 17 | Male | 13 | 18 | Average | 12 | Average | 57 | Superior |
| 33 | Female | 13 | 19 | Average | 12 | Average | 41 | Average |
| *25 | Male | 13 | 19 | Average | 0 | Very Poor | 43 | Average |
| 18 | Male | 13 | 22 | Average | 10 | Below Average | 38 | Average |
| 2 | Male | 13 | 24 | Average | 14 | Average | 54 | Superior |
| 15 | Male | 13 | 25 | Above Average | 17 | Average | 37 | Average |
| 5 | Male | 14 | 4 | Very Poor | 1 | Very Poor | 37 | Average |
| 29 | Male | 14 | 8 | Very Poor | 5 | Poor | 38 | Average |
| 6 | Female | 14 | 9 | Very Poor | 0 | Very Poor | 36 | Average |
| 24 | Female | 14 | 13 | Poor | 8 | Below Average | 41 | Average |
| 9 | Male | 14 | 14 | Poor | 10 | Below Average | 32 | Average |

| # | Sex | Age | Comp. Raw | Computation Scaled Score Category | W.P. Raw | Word Problem Scaled Category | Att. Raw | Math Attitudes Scaled Score Category |
|---|---|---|---|---|---|---|---|---|
| 26 | Male | 14 | 15 | Below Average | 8 | Below Average | 44 | Average |
| 12 | Male | 14 | 15 | Below Average | 7 | Poor | 58 | Superior |
| 19 | Male | 14 | 18 | Average | 12 | Average | 58 | Superior |
| 22 | Female | 14 | 19 | Average | 9 | Below Average | 34 | Average |
| *21 | Female | 14 | 23 | Average | 5 | Poor | 39 | Average |
| 34 | Female | 15 | 10 | Very Poor | 3 | Very Poor | 28 | Below Average |
| 4 | Female | 15 | 14 | Poor | 6 | Poor | 40 | Average |
| 3 | Male | 15 | 15 | Poor | 5 | Very Poor | 38 | Average |
| 1 | Female | 15 | 15 | Poor | 6 | Poor | 49 | Above Average |
| 32 | Male | 15 | 18 | Below Average | 13 | Average | 43 | Average |
| 27 | Male | 15 | 19 | Below Average | 13 | Average | 50 | Above Average |
| 23 | Female | 16 | 24 | Average | 11 | Below Average | 53 | Above Average |

*Note.* *Participants 11, 21, and 25 were outliers for their calculated difference between computation and word problem raw scores.

APPENDIX G

Output to Investigate Assumptions for a Dependent *t*-test

The first step in investigating the assumptions began with calculating a new variable, *differences*, by subtracting the raw word problem subtest score from the raw math computation subtest score. Based on the descriptive statistics, the skewness for differences between scores was 1.3 (Table 17). The results support the assumption of highly skewed, meaning that the data has abnormal distribution. Normal distribution would indicate a skewness between -1 and positive 1 (Field, 2018). The kurtosis for differences between scores was 1.8. As the kurtosis is between -3 and 3, this supports the assumption of a normal distribution (Field, 2018). Given Shapiro Wilk test of normality (S = .870, $p$ = .001; Table 17), the researcher concluded data was not normally distributed (Field, 2018). Figures 3, G2, and G3 demonstrate positively skewed data with outliers at the high end. Specifically, cases 11, 21, and 25 are outliers in the difference of the word problem and math subtest score.

Table 17

*Descriptive Statistics for TOMA-3 Instrument Differences*

| Differences Between TOMA-3 Tests | No. of Participants | *M* | *SD* | Min. | Max. | Range | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| Computations & Math Word Problems | 34 | 8.32 | 3.95 | 3 | 19 | 16 | 1.3 | 1.84 |

Table 18

*Test of Normality for Differences Between Computations and Math Word Problems*

| | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| Test of Normality for Differences | Statistics | *Df* | *p* | Statistics | *df* | *p* |
| Computations & Math Word Problems | .189 | 34 | .003 | .870 | 34 | .001 |

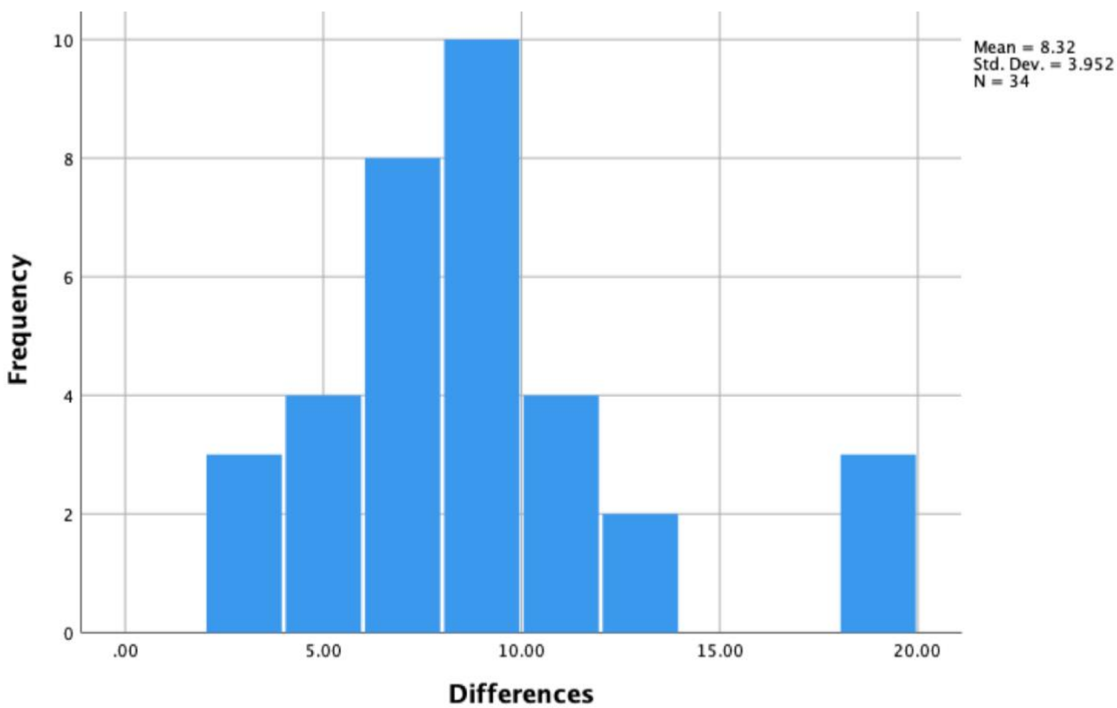



*Figure 3.* Histogram.

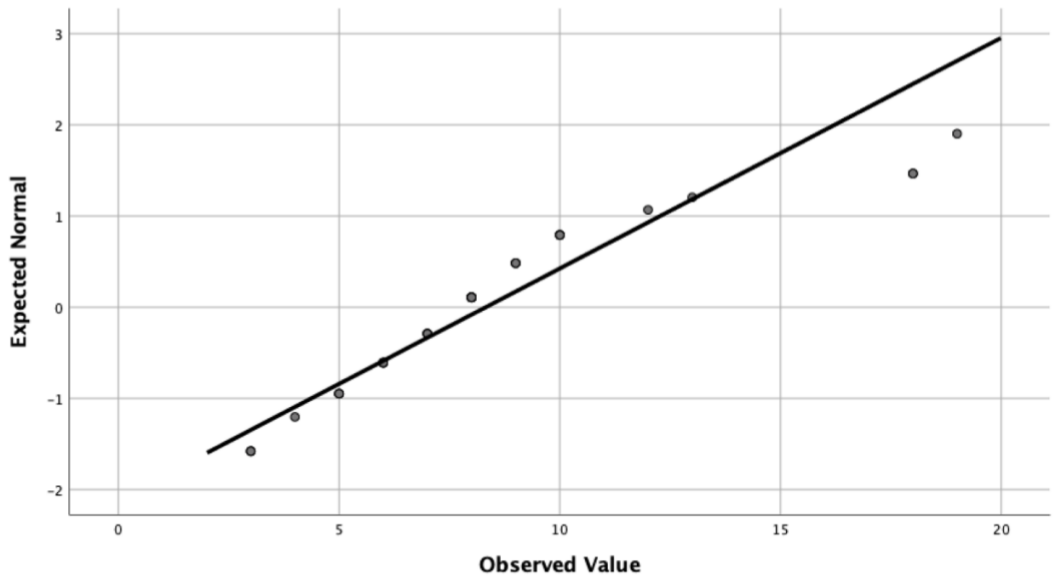



*Figure 4*. Normal Q-Q plot of differences.

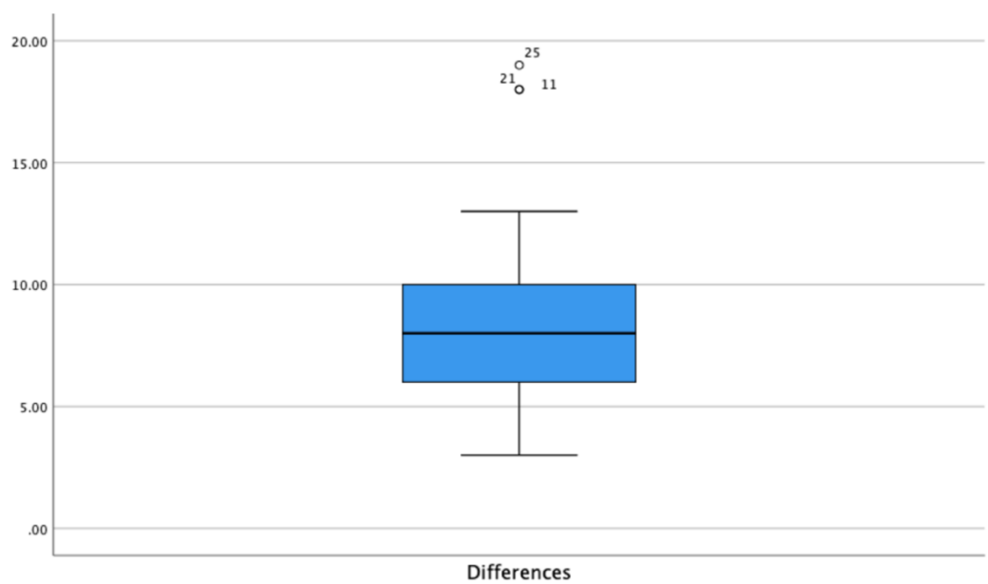



*Figure 5.* Box plot.

Therefore, that assumption of normality for linear models has not been met according to Shapiro-Wilk test of normality, Histogram, and QQ plot, and box plot.

Therefore, the researcher used a nonparametric version test similar to the dependent *t*-test.

## APPENDIX H

### Output to Investigate Assumptions for a Pearson's *r* Correlation

Descriptive statistics were conducted to determine if the data was normally distributed with the correlation of math attitudes, computations, and mathematic word problems (see Table 19). Based on the skewness, the skewness for math attitudes was .271, the skewness for computations was -.336, and the skewness for mathematic word problems was -.079. The researcher concluded that data are typically distributed based on both pieces of data being between -1 and 1 (Field, 2018). When determining the kurtosis, math attitudes were -.376, computations were .043, and mathematic word problems were -.478. Indicating that all the kurtosis values were between -3 and 3 indicated normal distribution. When observing the Q-Q plots for math attitudes (Figure 6), computations (Figure 7), and mathematic word problems (Figure 8), the points fall close to the line indicating normal distribution of scores.

Finding also suggests normality in (Table 20) is statistically nonsignificant given the Kolmogorov-Smirnov values of ($p$ = .200) for math attitudes, computations, and mathematics word problems scores. When observing boxplots for math attitudes (Figure 9), computations (Figure 10), and mathematic word problems (Figure 11), there were no outliers indicated and no missing cases and a normal distribution. The histograms for math attitudes (Figure 12), computations (Figure 13), and mathematic word problems (Figure 14) all have bell curves, symmetry, and all have a peak in the center, approximating a normal distribution.

In conclusion the assumption for normality with bivariate correlations were met according to the descriptive analysis of math attitudes, computations, and mathematic word problems (see Figures 10, 11, 12). Therefore, there was no need for a non-parametric correlation, and one can conclude that all the sample scores come from normally distributed data, which gives the data reliability (Fields, 2018).

Table 19

*Descriptive Statistics for Math Attitudes, Computations, and Math Word Problems*

| Descriptive Statistic | Number of Participants | Mean | SD | Minimum | Maximum | Median | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| Math Attitudes | 34 | 42.41 | 8.04 | 28 | 58 | 41.5 | .271 | -.376 |
| Computations | 34 | 15.73 | 5.1 | 4 | 25 | 16 | -.336 | .043 |
| Math Word Problems | 34 | 7.41 | 4.38 | 0 | 17 | 7.5 | -.079 | -.478 |

Table 20

*Test of Normality for Bivariate Correlation Between Math Attitudes, Computations and Math Word Problems*

| | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| Test of Normality for Bivariate Correlation | Statistics | *Df* | *p* | Statistics | *df* | *p* |
| Math Attitudes | .118 | 34 | .200 | .965 | 34 | .342 |
| Computations | .114 | 34 | .200 | .969 | 34 | .431 |
| Math Word Problems | .085 | 34 | .200 | .968 | 34 | .403 |

**Attitude about math**

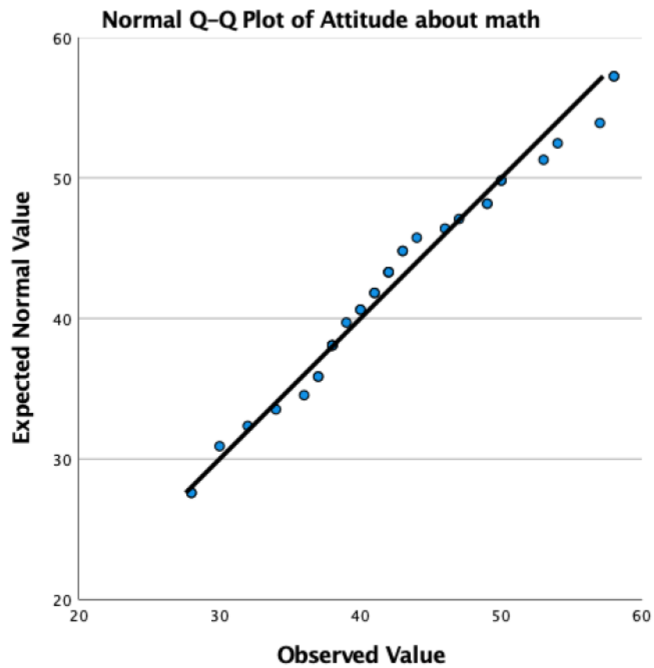



*Figure 6.* Q-Q plots for math attitudes.

**Computations**

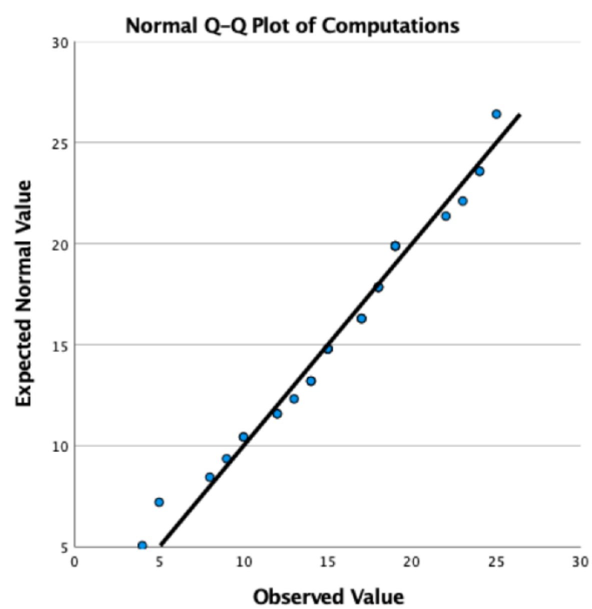



*Figure 7.* Q-Q plots for computations.

**Mathematic Word Problems**

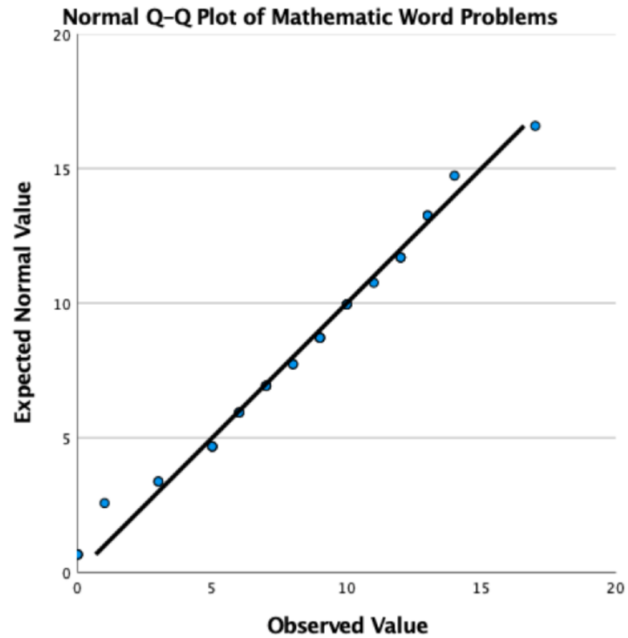



*Figure 8*. Q-Q plots for mathematic word problems.

**GGraph**

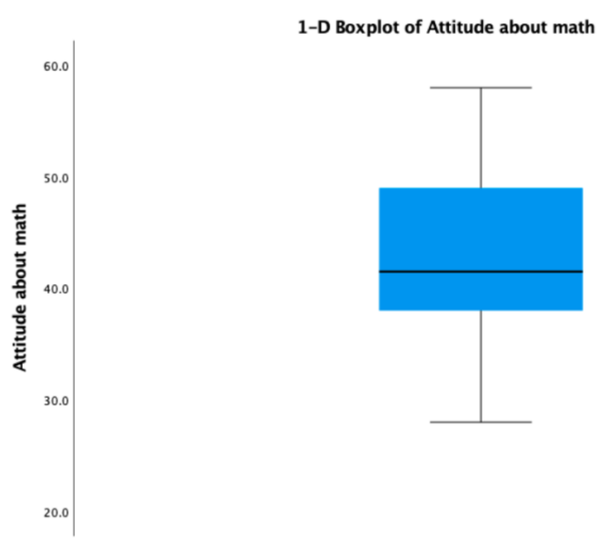



*Figure 9.* Box plots for math attitudes.

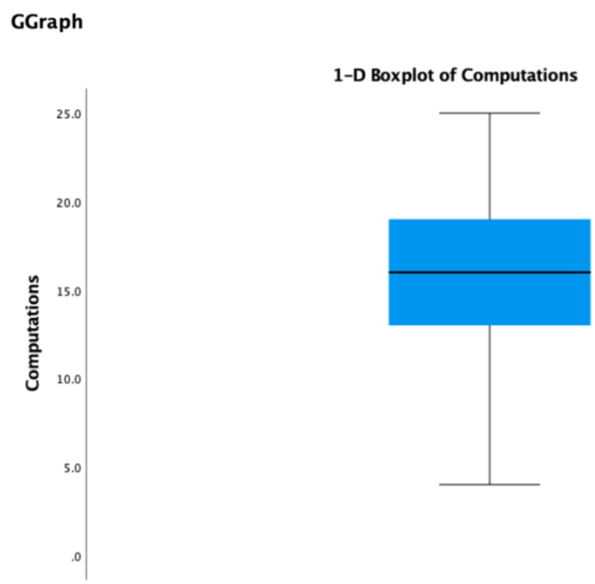



*Figure 10.* Box plots for computations.

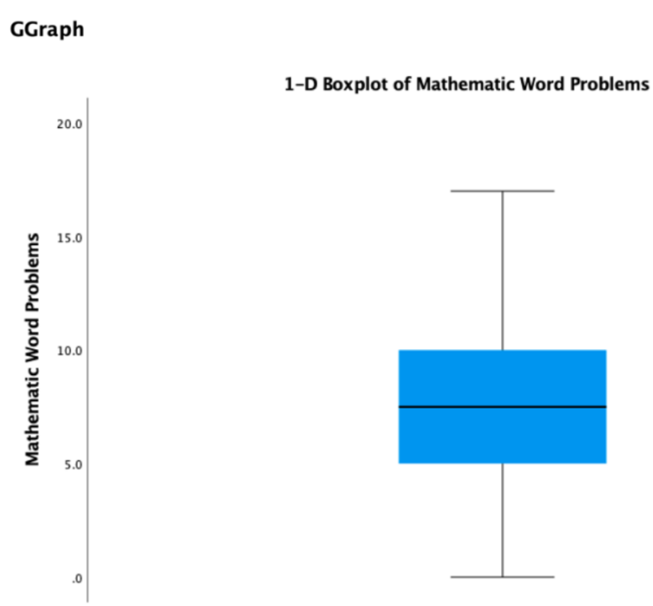



*Figure 11.* Box plots for mathematic word problems.

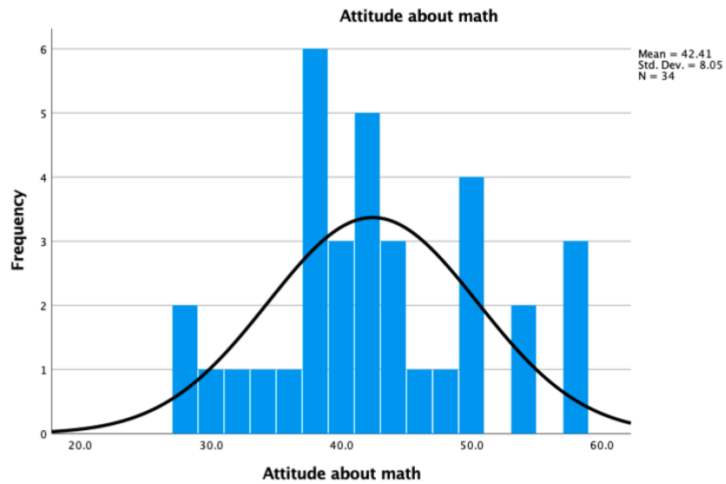



*Figure 12.* Histogram for math attitudes.

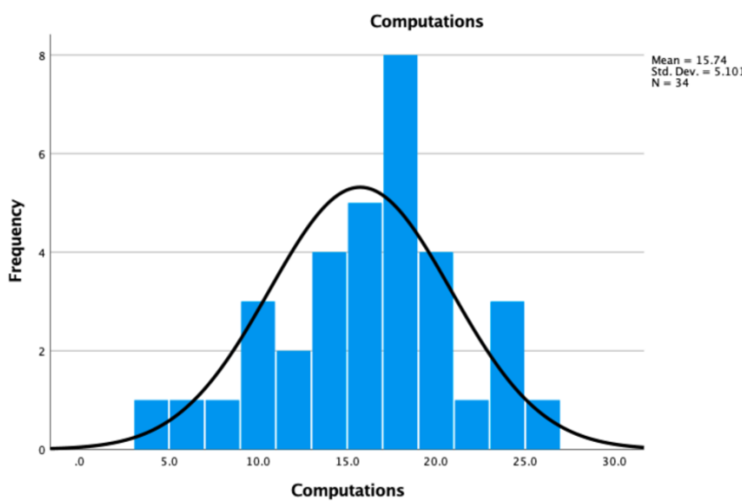



*Figure 13.* Histogram for computations.

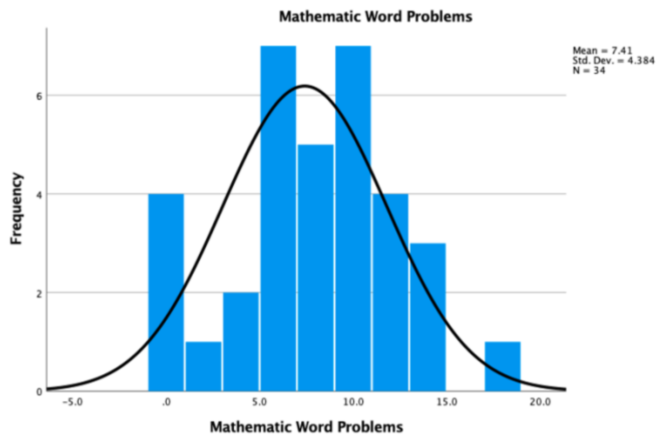



*Figure 14.* Histogram for mathematic word problems.

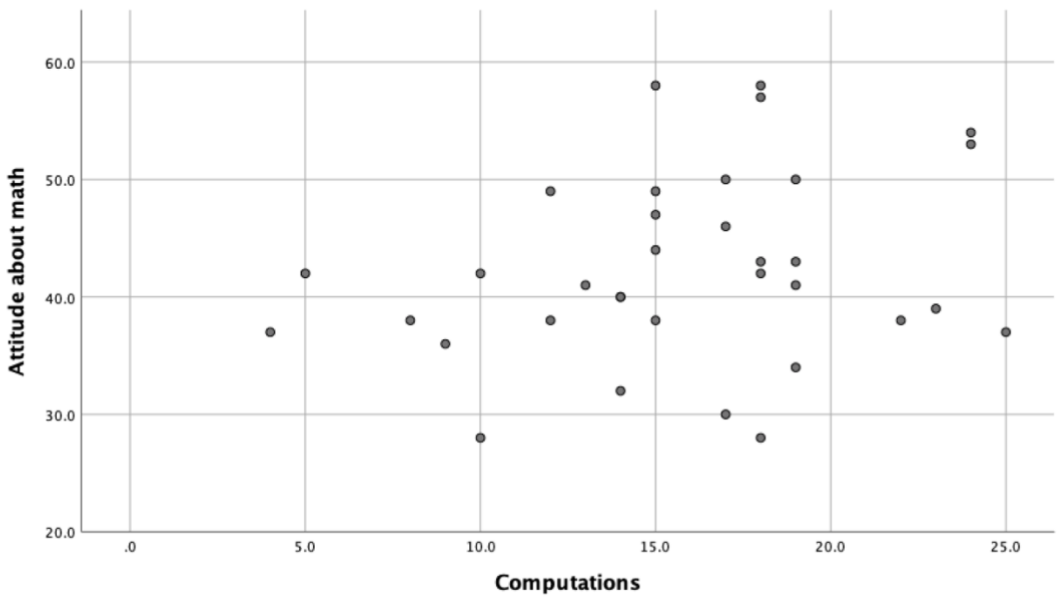



*Figure 15.* Correlation between attitudes and math computations.

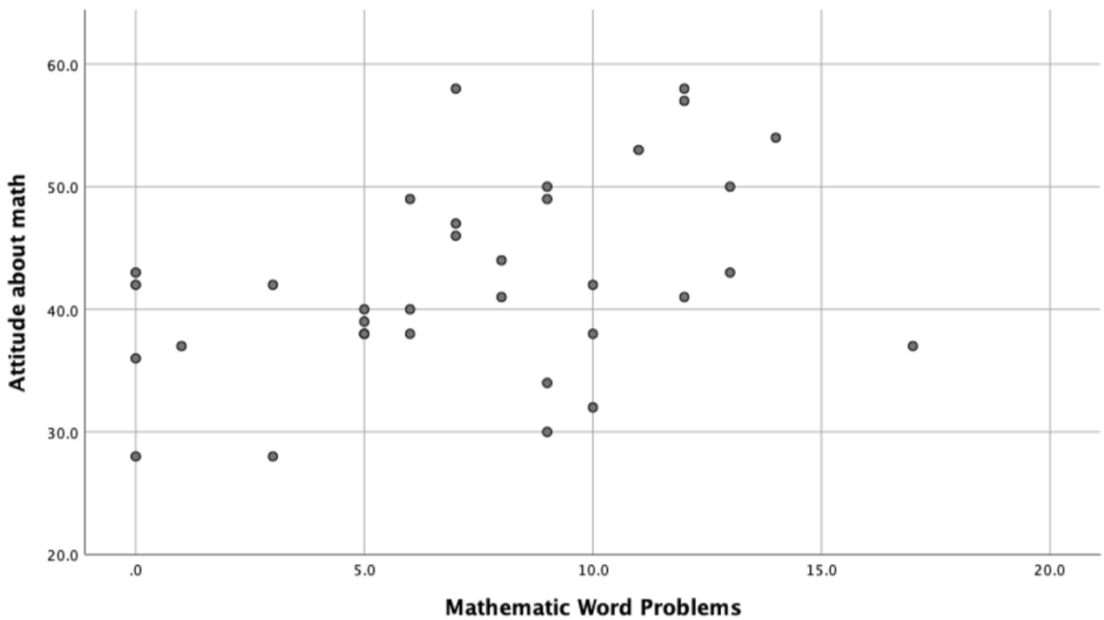



*Figure 16.* Correlation between attitudes and math word problems.

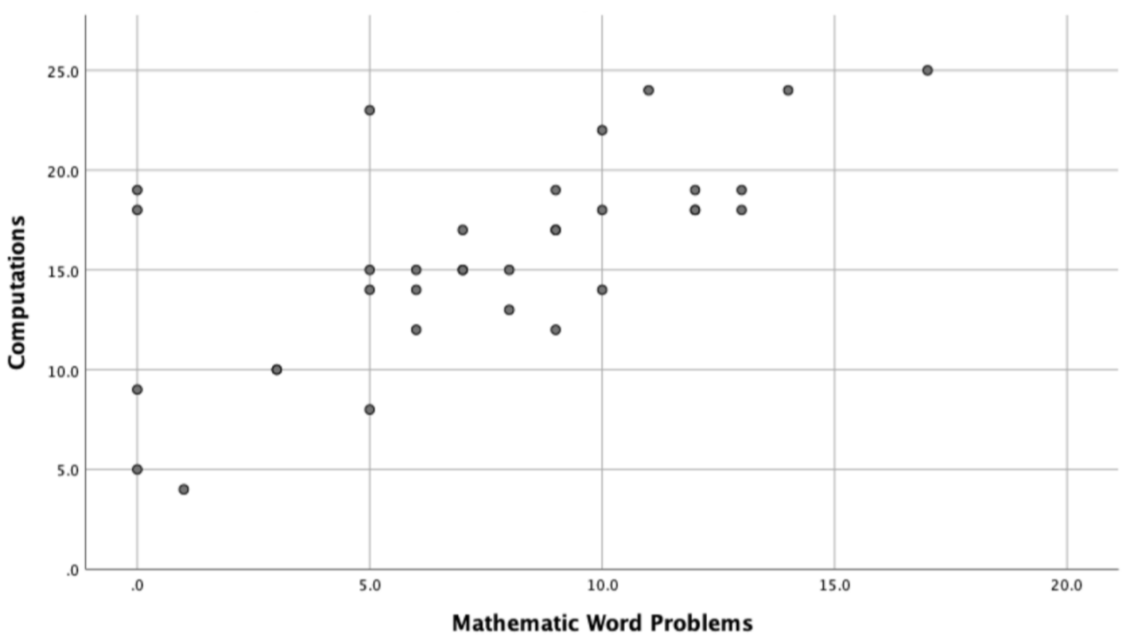



*Figure 17.* Correlation between math computations and math word problems.

BIBLIOGRAPHY

Americans United for Separation of Church and State. (2014, March). Texas education board changes rules for textbook review process. *Church & State Magazine*, *67*(3), 18. https://www.au.org/church-state/march-2014-church-state/people-events/texas-education-board-changes-rules-for-textbook

Anderson, S. E. (1990). Worldmath curriculum: Fighting Eurocentrism in mathematics. *The Journal of Negro Education*, *59*(3), 348–359. https://doi.org/10.2307/2295569

Apple, M. (1990). The text and cultural politics [Special Edition: Embattled Books; The State of the Text]. *Journal of Educational Thought*, *24*(3A), 17–33. https://www.jstor.org/stable/23768190

Aronson, B., & Laughter, J. (2016). The theory and practice of culturally relevant education: A synthesis of research across content areas. *Review of Educational Research*, *86*(1), 163–206. https://doi.org/10.3102/0034654315582066

Ashcroft, B. (1994). Africa and Australia: The post-colonial connection. *Research in African Literatures*, *25*(3), 161–170. https://www.jstor.org/stable/3819852

Bailey, D. A. (2018). *Smarter balanced math assessment: An examination of its construct validity for students with known reading and/or writing disabilities* (Publication No. 10811788) [Doctoral dissertation, Seattle Pacific University]. ProQuest Dissertations and Theses.

Barnett, W. S., Yarosz, D. J., Thomas, J., Jung, K., & Blanco, D. (2007). Two-way and monolingual English immersion in preschool education: An experimental comparison. *Early Childhood Research Quarterly*, *22*(3), 277–293. https://doi.org/10.1016/j.ecresq.2007.03.003

Barshay, J. (2019, December 26). *What 2018 PISA international rankings tell us about U.S. schools*. The Hechinger Report. https://hechingerreport.org/what-2018-pisa-international-rankings-tell-us-about-u-s-schools/

Barton, B. (1996). Making sense of ethnomathematics: Ethnomathematics is making sense. *Educational Studies in Mathematics*, *31*(1-2), 201–233. https://doi.org/10.1007/bf00143932

Berry, R. Q., III, & McClain, O. L. (2009). Voices, power, and multiple identities: African-American boys and mathematics success. *New England Mathematics Journal*, *41*, 17–26.

Berry, R. Q., III, Thunder, K., & McClain, O. L. (2011). Counter narratives: Examining the mathematics and racial identities of Black boys who are successful with school mathematics. *Journal of African-American Males in Education*, *2*(1), 10–23. https://www.researchgate.net/publication/258440963_Counter_Narratives_Examining_the_Mathematics_and_Racial_Identities_of_Black_Boys_who_are_Successful_with_School_Mathematics

Boulder Learning. (2013). *HELP math: Closing the achievement gap in math.* http://www.helpprogram.net/Purchasing.htm

Brown, B. A., Boda, P., Lemmi, C., & Monroe, X. (2019). Moving culturally relevant pedagogy from theory to practice: Exploring teachers' application of culturally relevant education in science and mathematics. *Urban Education*, *54*(6), 775–803. https://doi.org/10.1177/0042085918794802

Brown, V. L., Cronin, M. E., & Bryant, D. P. (2012). *Test of mathematics abilities* (3rd ed.). PRO-ED.

Brown, V. L., Cronin, M. E., & Bryant, D. P. (2013a). *Test of mathematics abilities: Examiner's manual* (3rd ed.). PRO-ED.

Brown, V. L., Cronin, M. E., & Bryant, D. P. (2013b). *Test of mathematics abilities* (3rd ed., TOMA-3). PRO-ED. https://www.proedinc.com/Downloads/14210TOMA-3WhitePaper.pdf

Bruno, L. C., & Baker, L. W. (1999). Math and mathematicians: *The history of math discoveries around the world*. U X L.

Bryant, T. L. (2017). *The influence of high school preparation on black male students' ability to succeed at the post-secondary level* (Publication No. 10690516) [Doctoral dissertation, California State University, Long Beach]. ProQuest Dissertations and Theses.

Camera, L. (2019, Dec 3). *U.S. Students show no improvement in math, reading, science on international exam.* US News. https://www.usnews.com/news/education-news/articles/2019-12-03/us-students-show-no-improvement-in-math-reading-science-on-international-exam

Carver-Thomas D., & Darling-Hammond L. (2017). *Teacher turnover: Why it matters and what we can do about it*. https://learningpolicyinstitute.org/product/teacher-turnover-report

Cawley, J. F., Fitzmaurice, A. M., Shaw, R., Kahn, H., & Bates, H. III. (1979). LD youth and mathematics: A review of characteristics. *Learning Disability Quarterly*, *2*(1), 29–44. https://doi.org/10.2307/1510837

Civil, M., & Khan, L. H. (2001). Mathematics instruction developed from a garden theme. *Teaching Children Mathematics*, *7*(7), 400–405. https://doi.org/10.5951/tcm.7.7.0400

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed,). Academic Press.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155–159.

Connor, C. M., & Craig, H. K. (2006). African American preschoolers' language, emergent literacy skills, and use of African American English: A complex relation. *Journal of Speech, Language, and Hearing Research*, *49*(4), 771–792. https://doi.org/10.1044/1092-4388(2006/055)

Crawford, L. (2013). Effects of an online mathematics curriculum for English language learners. *Computers in the Schools*, *30*(3), 248–270. https://doi.org/10.1080/07380569.2013.805665

Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research.* Sage.

Cronbach, L. K. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*, 297–334.

Crystal, D. (2008). *A dictionary of linguistics and phonetics* (6th ed.). Wiley-Blackwell.

Data Interaction for Texas Student Assessment. (2021). *Group summary performance levels for STAAR 3-8, State, Spring 2019*. https://txreports.emetric.net/

Davis, J. (2014). The mathematical experiences of Black males in a predominantly Black urban middle school and community. *International Journal of Education in Mathematics, Science and Technology*, *2*(3), 206–222. https://files.eric.ed.gov/fulltext/EJ1066358.pdf

Edens, K., & Potter, E. (2008). How students "unpack" the structure of a word problem: Graphic representations and problem solving. *School Science and Mathematics*, *108*(5), 184–196. https://doi.org/10.1111/j.1949-8594.2008.tb17827.x

Ensign, J. (2003). Including culturally relevant math in an urban school. *Educational Studies*, *34*(4), 414–423. https://philpapers.org/rec/ENSICR

Estes, T. H., Estes, J. J., Richards, H. C., & Roettger, D. M. (1981). *Estes attitude scales*. Pro-Ed.

Farran, D. C., Meador, D., Christopher, C., Nesbitt, K. T., & Bilbrey, L. E. (2017). Data-driven improvement in prekindergarten classrooms: Report from a partnership in an urban district. *Child development*, *88*(5), 1466–1479. https://doi.org/10.1111/cdev.12906

Field, A. (2018). *Discovering statistics using IBM® SPSS® Statistics* (5th ed.). Sage.

Finley, E. P. , Pugh, J. A., Lanham, H. J., Leykum, L. K., Cornell, J., Veerapaneni, P., & Parchman, M. L. (2013). Relationship quality and patient-assessed quality of care in VA primary care clinics: Development and validation of the work relationships scale. *Annals of Family Medicine*, *11*(6), 543–549. https://doi.org/10.1370/afm.1554

Flores, O. J. (2018). (Re) constructing the language of the achievement gap to an opportunity gap: The counternarratives of three African American women school leaders. *Journal of School leadership*, *28*(3), 344–373. https://doi.org/10.1177/105268461802800304

Folsom, N. (2016). *A mixed methods study of academic achievement and parental perspectives in a dual language program* (Publication No. 10188988) [Doctoral dissertation, Loyola University Chicago]. ProQuest Dissertations and Theses.

Fox, B. L. (2011). *A critical examination of Texas mathematics achievement in grades three through eight by mathematics objective across race/ethnicity, gender, and socioeconomic status* (Publication No. 3500147) [Doctoral dissertation, Texas A&M University]. ProQuest Dissertations and Theses.

Foy-Watson, S., Hunt, T. C., Carper, J. C., & Lasley, T. J. (Eds.). (2010). *Encyclopedia of educational reform and dissent*. Sage.

Freeman, B., & Crawford, L. (2008). Creating a middle school mathematics curriculum for English-language learners. *Remedial and Special Education*, *29*(1), 9–19. https://doi.org/10.1177/0741932507309717

Fullam, J. P. (2017). From seeing to believing: Using instructional video to develop culturally responsive teaching. *Journal for Multicultural Education, 11*(2), 131–148. https://doi.org/10.1108/jme-09-2016-0053

Gao, Y. (2017). *Motivating highly capable students through heritage language instruction: An investigation into an after-school program in Lake Washington School District, WA* (Publication No. 10259658) [Doctoral dissertation, University of Washington]. ProQuest Dissertations and Theses.

Gardner, M. (2001). *The colossal book of mathematics: Classic puzzles, paradoxes, and problems*. WW Norton & Company.

Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice*. Teachers College Press.

Gewertz, C. (2015, February 17). *States ceding power over classroom materials.* Education Week. https://www.edweek.org/teaching-learning/states-ceding-power-over-classroom-materials/2015/02

Ginsburg, H. P., & Baroody, A. J. (2003). *TEMA-3: Test of early mathematics ability* (3rd ed.). Pro-ed.

González, G. (2015). The use of linguistic resources by mathematics teachers to create analogies. *Linguistics and Education*, *30*(6), 81–96. https://doi.org/10.1016/j.linged.2015.03.012

Gowers, T., Barrow-Green, J., & Leader, I. (Eds.). (2008). *The Princeton companion to mathematics*. Princeton University Press.

Griffith, D. (Director). (1915). *The birth of a nation.* Part of the Series: Kino Lorber Essential Collection. Kanopy Streaming. https://www.kanopy.com/product/birth-nation-0

Guglielmi, R. (2012). Math and science achievement in English language learners: Multivariate latent growth modeling of predictors, mediators, and moderators. *Journal of Educational Psychology*, *104*(3), 580–602. https://doi.apa.org/doi/10.1037/a0027378

Harper, F. D., Braithwaite, K., & LaGrange, R. (1998). Ebonics and academic achievement: The role of the counselor. *The Journal of Negro Education*, *67*(1), 25–34. https://doi.org/10.2307/2668237

Hawkins, J. A. (2014). *Cross-linguistic variation and efficiency*. Oxford University Press.

Hefley, J. C. (1979). *Are textbooks harming your children? Norma and Mel Gabler take action-and show you how!* Mott Media.

Hewlett, G. (1988). *A descriptive study of textbook preparation programs and state level textbook adoption in Texas* (Publication No. 8814748) [Doctoral dissertation, East Texas State University]. ProQuest Dissertations and Theses.

Hiebert, J., Gallimore, R., Garnier, H., Givvin, K. B., Hollingsworth, H., Jacobs, J., & Stigler, J. (2003). Teaching mathematics in seven countries: Results from the TIMSS 1999 video study. *Education Statistics Quarterly*, *5*(1), 7–15. https://doi.org/10.1037/e610352011-003

Hobbes, M. (2017). *Why America needs Ebonics now.* Huffington Post. https://highline.huffingtonpost.com/articles/en/ebonics/

Hollie, S. D. (2000). *African American students as standard English language learners: An alternative approach* (Publication No. DP25610) [Doctoral dissertation, University of Southern California]. ProQuest Dissertations and Theses.

Hollie, S. D. (2001). Acknowledging the language of African American students: Instructional strategies. *The English Journal*, *90*(4), 54–59. https://doi.org/10.2307/821903

Hresko, W. P., Schlieve, P. L., Herron, S. R., Swain, C., & Sherbenou, R. J. (2003). *Comprehensive mathematics abilities test*. PRO-ED.

Janssen, S. (2020). *The World Almanac and book of facts*. World Almanac.

Jitendra, A., Hoff, K., & Beck, M. (1999). Teaching middle school students with learning disabilities to solve word problems using a schema-based approach. *Remedial and Special Education*, *20*(1), 50–64. https://doi.org/10.1177/074193259902000108

Johnson, S. (2016, Dec 6). *Math scores drop, but the achievement gap narrows for U.S. teens in international PISA assessment.* Edsurge. https://www.edsurge.com/news/2016-12-06-math-scores-drop-but-achievement-gap-narrows-for-u-s-teens-in-international-pisa-assessment

Jones, T. (2017). *Measuring the effects of an accommodated math curriculum: Closing the achievement gap in minority and low socioeconomic middle school students* (Publication No, 10288416) [Doctoral dissertation, Northcentral University]. ProQuest Dissertations and Theses.

Kikas, E., Mädamürk, K., Palu, A., & Kikas, E. (2019). What role do comprehension-oriented learning strategies have in solving math calculation and word problems at the end of middle school? *The British Journal of Educational Psychology*, *90*(S1), 105–123. https://doi.org/10.1111/bjep.12308

Kim, S. (2011). Does teacher educational training help the early math skills of English language learners in Head Start? *Children and Youth Services Review*, *33*(5), 732–740. https://doi.org/10.1016/j.childyouth.2010.11.019

Klein, G. (1985). *Reading into racism: Bias in children's literature and learning materials*. Routledge & Kegan Paul.

Krawec, J., Huang, J., Montague, M., Kressler, B., & Melia de Alba, A. (2013). The effects of cognitive strategy instruction on knowledge of math problem-solving processes of middle school students with learning disabilities. *Learning Disability Quarterly*, *36*(2), 80–92. https://doi.org/10.1177/0731948712463368

Ladson-Billings, G. (1997). It doesn't add up: African American students' mathematics achievement. *Journal for Research in Mathematics Education*, *28*(6), 697–708. https://doi.org/10.5951/jresematheduc.28.6.0697

Lagasse, P. (Ed.). (2018). Linguistics. *The Columbia encyclopedia* (8th ed.). Columbia University Press.

Lehr, D. (2014). *The birth of a nation: How a legendary filmmaker and a crusading editor reignited America's civil war* (1st ed.). PublicAffairs™.

Los Angeles Unified School District. (2017). *BUL-6870.0: Culturally and linguistically responsive pedagogy pk-12 professional development module*.

https://achieve.lausd.net/cms/lib/CA01000043/Centricity/Domain/217/BUL-6870.0%20CLR%20PD%20Module%20Bulletin%20Revised.pdf

Mattarella-Micke, A., Beilock, S., & Mattarella-Micke, A. (2010). Situating math word problems: The story matters. *Psychonomic Bulletin & Review*, *17*(1), 106–111. https://doi.org/10.3758/pbr.17.1.106

Maylor, U. (2014). *Teacher training and the education of Black children: Bringing color into difference*. Routledge.

McCaig, S. L. (2020). *The academic achievement gap: Learning from schools that bridge the academic achievement gap between African American students and Caucasian American students* [Unpublished doctoral dissertation]. Abilene Christian University.

McGaughy, L. (2014). Lone Star influence on textbooks waning nationwide. *Houston Chronicle*. https://www.houstonchronicle.com/news/houston-texas/education/article/Lone-Star-influence-on-textbooks-waning-nationwide-5921656.php

Mejia Colindres, C. (2015). *The role of translanguaging in Latino mathematics classrooms* (Publication No. 3725339) [Doctoral dissertation, Texas State University-San Marcos]. ProQuest Dissertations and Theses.

Merriam-Webster. (n.d.a). Anglocentric. In *Merriam-Webster.com dictionary*. Retrieved February 17, 2020, from https://www.merriam-webster.com/dictionary/Anglocentric

Merriam-Webster. (n.d.b). Homophyms. In *Merriam-Webster.com dictionary*. Retrieved February 17, 2020, from https://www.merriam webster.com/dictionary/homophyms

Merriam-Webster. (n.d.c). Homophone. In *Merriam-Webster.com dictionary*. Retrieved February 17, 2020, from https://www.merriam webster.com/dictionary/homophone

Merrow, J. (1979). *Textbook censors, Norma and Mel Gabler.* National Public Radio.

Moses, R. P., & Cobb, C. E. (2002). *Radical equations: Civil rights from Mississippi to the algebra project.* Beacon Press.

Murray, M. A. (1995). *Culturally, linguistically appropriate approaches for teaching composition skills to third-grade African-American students* (Publication No. 9908005) [Doctoral dissertation, University of San Francisco]. ProQuest Dissertations and Theses.

National Center for Education Statistics. (2019). Trends in international mathematics and science study: *Data interaction for all 60 countries.* https://nces.ed.gov/timss/results19/index.asp#/math/intlcompare

National Center for Education Statistics. (2020). *Status of education in rural areas: Average number of teaching years*. https://nces.ed.gov/pubs2007/ruraled/tables/tablea3_8.asp

OECD. (2019). *PISA 2018 database.* https://www.oecd.org/pisa/data/2018database/

Ogbu, J. (1999). Beyond language: Ebonics, proper English, and identity in a Black-American speech community. *American Educational Research Journal*, *36*(2), 147–184. https://doi.org/10.3102/00028312036002147

Orosco, M. (2014). Word problem strategy for Latino English language learners at risk for math disabilities. *Learning Disability Quarterly: Journal of the Division for Children with Learning Disabilities*, *37*(1), 45–53. https://doi.org/10.1177/0731948713504206

Orosco, M., Swanson, H. L., O'Connor, R., & Lussier, C. (2011). The effects of dynamic strategic math on English language learners' word problem solving. *The Journal of Special Education*, *47*(2), 96–107. https://doi.org/10.1177/0022466911416248

Perry, T. (1998). "I 'on know why they be trippin'": Reflections on the Ebonics debate. In T. Perry & L. D. Delpit (Eds.), *The real Ebonics debate: Power, language, and the education of African-American children* (pp. 3–16). Beacon Press.

Piedra, M., Araujo, B., Esquinca, A., & Delgado-Gaitan, C. (2018). *Educating across borders: The case of a dual language program on the U.S.-Mexico border*. The University of Arizona Press.

Powell A. B. (2004, July 14-18). The diversity backlash and the mathematics agency of students of color. In M. J. Hoines, & A. B. Fuglestad (Eds.), *Proceedings of the twenty-eighth conference of the international group for the psychology of mathematics education* (Vol. 1, pp. 37–54). Bergen, Norway. https://files.eric.ed.gov/fulltext/ED489178.pdf

Powell, S., Stevens, E., & Hughes, E. (2019). Math language in middle school: Be more specific. *Teaching Exceptional Adolescents*, *51*(4), 286–295. https://doi.org/10.1177/0040059918808762

Quintana, S., & Mahgoub, L. (2016). Ethnic and racial disparities in education: Psychology's role in understanding and reducing disparities. *Theory Into Practice*, *55*(2), 94–103. https://doi.org/10.1080/00405841.2016.1148985

Rebolini, A. (2017). These 16 books explain White supremacy in the U.S. https://www.buzzfeednews.com/article/ariannarebolini/must-read-books-about-white-supremacy-in-the-us

Riley T. (2012). *Messing with Texas textbooks.* Doctoroff Media Group. https://billmoyers.com/content/messing-with-texas-textbooks/

Rodriguez, D., Carrasquillo, A., & Lee, K. (2014). *The bilingual advantage: Promoting academic development, biliteracy, and native language in the classroom.* Teachers College Press.

Rothstein, R. (2004). *Class and schools: Using social, economic, and educational reform to close the Black-white achievement gap*. Teachers College Press.

Rubin, B. C., Abu El-Haj, T. R., Graham, E., & Clay, K. (2016). Confronting the urban civic opportunity gap: Integrating youth participatory action research into teacher education. *Journal of Teacher Education*, *67*(5), 424–436. https://doi.org/10.1177/0022487116667195

Salkind, N. J. & Frey, B. B. (2020). *Statistics for people who (think they) hate statistics* (7th ed.). Sage.

Schoen, H., & Ansley, T. (2005). *Iowa algebra aptitude test* (5th ed.). Riverside Insights.

Schwerdt, G., & West, M. R. (2013). The impact of alternative grade configurations on student outcomes through middle and high school. *Journal of Public Economics*, *97*, 308–326. https://doi.org/10.1016/j.jpubeco.2012.10.002

Scudella V. (2013). *K-12: Textbook adoption*. Education Commissions of States. https://www.ecs.org/clearinghouse/01/09/23/10923.pdf

Shenk, S. L., & Thompson, D. R. (2003). School mathematics curricula: Recommendations and issues. In S. L. Shenk, & D. R. Thompson (Eds.), *Standards-based school mathematics curricula: What are they*? *What do students learn?* (pp. 3–27). Routledge.

Statulator. (2014). *Sample size calculator for comparing paired differences*. http://statulator.com/SampleSize/ss2PM.html#

Stein, L. (2012). The art of saving a failing school: While some legislators believe that closing failing schools is the smarter choice, many schools can be turned around with strong leadership, effective communication, and immediate action. *Phi Delta Kappan*, *93*(5), 51–55. https://doi.org/10.1177/003172171209300512

Stone, R., & Atta, S. (2007). *Best practices for teaching mathematics: What award-winning classroom teachers do*. Corwin Press.

Strauss V. (2014). *Proposed Texas textbooks are inaccurate, biased, and politicized, new reports finds.* The Washington Post. https://www.washingtonpost.com/news/answer-sheet/wp/2014/09/12/proposed-texas-textbooks-are-inaccurate-biased-and-politicized-new-report-finds/

Swanson, A. (2013). Generative strategies, working memory, and word problem solving accuracy in children at risk for math disabilities. *Learning Disability Quarterly: Journal of the Division for Children with Learning Disabilities*, *36*(4), 203–214. https://doi.org/10.1177/0731948712464034

Swisher, J., Popal, S., Suzuki, S., Medcalf-Turner, P., & Rambo, H. (2012). *Bridging the achievement gap through second language acquisition methodology*. (Publication No. 1520175) [Doctoral dissertation, Saint Mary's College of California]. ProQuest Dissertations and Theses.

Tan, J. (1998). *Effects of rephrasing word problems on sixth-grade ESL and native English-speaking students' mathematics performance and attitudes* (Publication No. 9912807) [Doctoral dissertation, Texas Tech University]. ProQuest Dissertations and Theses.

Texas Education Agency. (2019). *STAAR released test questions*: *Release test forms and answer keys for STAAR 6th grade, State, Spring 2019*. https://tea.texas.gov/Student_Testing_and_Accountability/Testing/State_of_Texas_Assessments_of_Academic_Readiness/STAAR_Released_Test_Questions

Texas Education Agency. (2020a). *SBOE members*. https://tea.texas.gov/about-tea/leadership/state-board-of-education/sboe-board-members/sboe-members

Texas Education Agency. (2020b). *Snapshot 2019: District detail search*. https://rptsvr1.tea.texas.gov/perfreport/snapshot/2019/district.srch.html

The Kentucky State Advisory Committee. (2007). *Equal education opportunity: An analysis of the racial achievement gap in Kentucky urban schools*. U.S. Commission on Civil Rights. https://www.usccr.gov/pubs/docs/022007_KYEdgapreport.pdf

Thevenot B. (2010) *The textbook myth.* The Texas Tribune. https://www.texastribune.org/2010/03/26/texas-textbooks-national-influence-is-a-myth/

Thompson, L.R., & Davis, J. (2013). The meaning high-achieving African-American males in an urban high school ascribe to mathematics. *The Urban Review*, *45*(4), 490–517. http://dx.doi.org/10.1007/s11256-013-0267-0

Timsit, A., & Merelli, A. (2018). *Sensitivity training needed: For 10 years, students used a history textbook that says not all slaves were unhappy.* https://qz.com/1273998/for-10-years-students-from-texas-have-been-using-a-history-textbook-that-says-not-all-slaves-were-unhappy/

Tran, L., Sanchez, T., Arellano, & Swanson, H. L. (2011). A meta-analysis of the RTI literature for children at risk for reading disabilities. *Journal of Learning Disabilities*, *44*(3), 283–295. https://doi.org/10.1177/0022219410378447

U.S. Census Bureau. (2010). *The statistical abstract of the United States: 2011* (130th ed.). https://www.census.gov/library/publications/2010/compendia/statab/130ed.html

van Garderen, D. (2006). Spatial visualization, visual imagery, and mathematics problem solving of students with varying abilities. *Journal of Learning Disabilities*, *39*(6), 496–506. https://doi.org/10.1177/00222194060390060201

Van Garderen, D. (2007). Teaching students with LD to use diagrams to solve mathematics word problems. *Journal of Learning Disabilities*, *40*(6), 540–553. https://doi.org/10.1177/00222194070400060501

van Garderen, D., Scheuermann, A., & Jackson, C. (2013). Examining how students with diverse abilities use diagrams to solve mathematics word problems. *Learning Disability Quarterly*, *36*(3), 145–160. https://doi.org/10.1177/0731948712438558

Warner, E. (2007). *A Black classroom culture: Student code-switching in an inner city secondary school* (Unpublished Doctoral dissertation). University of Maryland.

Williams, R. L. (1997). The ebonics controversy. *Journal of Black Psychology*, *23*(3), 208–214. https://doi.org/10.1177/00957984970233002

Yacovone, D. (2018). *Textbook racism: How scholars sustained White supremacy*. https://www.chronicle.com/article/How-Scholars-Sustained-White/243053

Zhang, D., & Xin, Y. P. (2012). A follow-up meta-analysis for word-problem-solving interventions for students with mathematics difficulties. *The Journal of Educational Research*, *105*(5), 303–318. https://doi.org/10.1080/00220671.2011.627397