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Adding It Up: The Effects of Math Curriculum on Third and Fourth Grade ACT Aspire Math Scores in Arkansas

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ADDING IT UP: THE EFFECTS OF MATH CURRICULUM ON THIRD AND FOURTH GRADE ACT ASPIRE MATH SCORES IN ARKANSAS

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"She is clothed with strength and dignity, and she laughs without fear of the future."

Proverbs 31:25

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Abstract

Over the last 62 years, mathematics reform has occurred due to a political push after results from a major survey or report were released stating that the United States scored lower than other countries. With each reform effort, teaching methods were changed to match the new initiative. Math curriculum was a key point in each of these reform efforts. In 2015, Arkansas adopted ACT Aspire as the statewide assessment, and in 2017 Arkansas adopted Arkansas State Standards. Although Arkansas adopted ACT Aspire and Arkansas State Standards, Arkansas does not require school districts to adopt a curriculum. The purpose of this quantitative, causal-comparative study was to explore the relationship between math curriculums, ACT Aspire Scores, and student demographics in Arkansas among students in grades three and four. The findings of this study found that there was a significant difference between math curricula and ACT Aspire math scores for students in third and fourth grade. Further, this study also found a significant difference between student grade level mean scores based on ACT Aspire math scores for students in third and fourth grade.

Keywords: ACT Aspire, math curriculum

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CHAPTER 1: INTRODUCTION

Background of the Problem

Over the last 100 years, mathematics reform in the United States has been limited to four major occurrences: (a) the beginning of mathematics in schools, (b) the "new math" movement, (c) No Child Left Behind, and (d) Race to the Top (Howell, 2015; Stanic & Kilpatrick, 1992). Each major reform was due to a political push after results from a major report or survey were released showing that mathematics was lacking in the US compared to other countries (Klein, 2003). Each push was always filled with excitement and urgency, only to be followed with confusion causing teachers to return to their comfort zone (Green, 2014). Green (2014) stated that the US was great at developing new methods for teaching mathematics; however, the issue was finding someone who was willing to teach those methods.

Throughout all four major occurrences, the main debate has been between content and pedagogy (Klein, 2003). Danielson (2011) defines content as the subject material and pedagogy as the way the teacher teaches the subject material. Content and pedagogy work with one another; however, one may also cause limitations on the other if the two are not balanced (Klein, 2003).

Curriculum and academic standards have also been key topics in education reform. The first mathematics curriculum was developed as part of the "new math" movement during the late 1950's and early 1960's, causing confusion rather than clear explanations (Stanic & Kilpatrick, 1992). Although a curriculum was developed in the 1960's, the first mathematics national standards initiative did not take place until the late 1980's (Stanic & Kilpatrick, 1992). For accountability purposes, standardized assessments were mandated to ensure states were teaching to the new standards (Stanic & Kilpatrick, 1992).

Arkansas adopted state academic standards, also referred to as the benchmark standards, for the first time during the mid-1990's in response to the Improving America's Schools Act of 1994 (Walking, Ash, & Ritter, 2014). In 2009, the Common Core Initiative began as part of the Race to the Top movement, and in 2010, the Common Core State Standards (CCSS) were released as the new national standards (Walkling et al., 2014). More than three-fourths of the states, including Arkansas, adopted The Common Core State Standards.

Many textbooks and curricular programs failed to meet the new standards; however, some continued to claim that they were Common-Core aligned (Walking et al., 2014). During the 2015-16 school year, more than 80% of elementary math teachers in the US were using curriculum that did not completely align with CCSS (Schaffhauser, 2018). Although Arkansas did not have an adopted curriculum requirement, school districts were still required to provide instruction based on CCSS.

The Race to the Top initiative accountability requirements also led to two new standardized assessment options in 2013: Partnership for Assessment of Readiness for College and Careers (PARCC) and Smarter Balance (Walkling et al., 2014). The Arkansas Department of Education (ADE), along with 23 other states, adopted PARCC for the 2013-14 and 2014-15 school years. In 2015, ADE adopted the ACT Aspire (as a replacement for PARCC) for the 2015-16 school year. Arkansas and Alabama were the only two states utilizing the ACT Aspire in grades 3-10; however, Alabama adopted another assessment for the 2017-18 school year. The ACT Aspire continues to be the state mandated assessment in Arkansas for grades 3-10.

Another focus of this study included demographics in mathematics, specifically gender. Until the early 1800's, only boys learned arithmetic in a formal setting, while girls learned it through life experiences (Waggener, 1996). Researchers also believe that the gender gap exists based on how males and females respond to the competitive aspect of mathematics (Neiderle & Vesterlund, 2010).

Statement of the Problem and Purpose of the Study

Arkansas transitioned from CCSS to Arkansas State Standards in 2017, the third change in academic standards for Arkansas in the last 10 years (Arkansas Bureau of Legislative Research, 2017). The Arkansas State Standards are Common Core-based and require no change to the curriculum utilized within a school district. Although all school districts in the state of Arkansas are mandated to utilize the Arkansas State Standards to guide instruction, schools are not required to adopt a curriculum. School districts in the Guy-Fenter Educational Cooperative were surveyed on their current math curriculum in November 2018, and half of the districts who responded to the survey use Eureka Math or Engage NY. However, currently, little to no research has been completed to determine if a specific curriculum has an effect on ACT Aspire math scores in grades three and four. Thus, the purpose of this causal-comparative study was to explore the relationship between math curriculums, ACT Aspire Scores, and student demographics in Arkansas among students in grades three and four.

Definition of Terms

For the purpose of this study, the key terminology are defined as follows:

- ACT Aspire: A standardized, achievement assessment given to students in grades three through twelve which determines a student's readiness level for college or a career in five areas: English, reading, math, science and writing (Institute of Education Sciences, 2017)
- Arkansas Department of Education (ADE): ADE was developed through Act 169 of 1931 and consists of five divisions overseeing all aspects of every public school, including charter schools, in Arkansas (Encyclopedia of Arkansas History and Culture, 2015).
- Arkansas State Standards: Standards that provide focus for literacy and math instruction by detailing what students should know and be able to do (Arkansas Department of Education, 2014).
- Common Core State Standards (CCSS): National "college and career ready" standards to guide instruction, which were written as part of the Race to the Top campaign (Walkling et al., 2014).
- Demographics: specific characteristics of a population, including but not limited to, age, race, gender, ethnicity, religion, income, education, marital status, family size, health and disability status (Salkind, 2010).
- Eureka Math: A math curriculum developed by Great Minds for grades Pre-Kindergarten through Twelve based completely on Common Core State Standards (Great Minds, 2016).
- Gender: A specific culture's perception of a person's biological sex (APA, 2012).
- Grade Level: The level of which a student progresses starting at the age of five (Loo, 2018).

- Guy-Fenter Cooperative: One of 15 cooperatives in Arkansas serving area member schools by providing professional development and assistance to meet the needs of the populations served through effective educational opportunities (Guy Fenter Education Cooperative, 2019).
- Math Curriculum: The resources and/or materials adopted by a school district and provided to a teacher to guide instruction in math (Slavin & Lake, 2008).
- “New Math” Movement: The new math movement started in the 1950’s and focused on the combination of understanding and skills instruction (Klein, 2003).

Research Questions and Hypotheses

- RQ1: What effect, if any, does a math curriculum have on third and fourth grade ACT Aspire math scores in Arkansas?
    - H1: There will be no significant difference between third and fourth grade ACT Aspire math scores based on math curriculum.
- RQ2: How do demographic factors combined with curriculum affect third and fourth ACT Aspire math scores?
    - H2: Math curriculum and gender have a combined effect on third and fourth grade ACT Aspire math scores.
    - H3: Math curriculum and student grade level will have a combined effect on third and fourth grade ACT Aspire math scores.
    - H4: Student grade level and gender will have a combined effect on third and fourth grade ACT Aspire math scores.

Significance of the Study

Various stakeholder groups within the Arkansas education system could possibly be affected by the results of this study. ADE could use this information when evaluating math curriculums for recommendation to districts. The findings of this study could also provide educators with a new perspective on the math curriculums utilized in schools within the Guy-Fenter Educational Cooperative area. This data will help educators and school officials determine which curriculum is needed to best serve their students.

Assumptions

In this study, it was assumed teachers understand the Arkansas State Mathematics Standards and teach the school's math curriculum with fidelity. It was also assumed that the ACT Aspire Math Assessment is a reliable and valid measure of student learning among third and fourth graders. It was also assumed that students put forth their best effort when completing the ACT Aspire Math Assessment.

Limitations

This study only included third and fourth grade students' ACT Aspire math scores within the Guy-Fenter Educational Cooperative in Arkansas, limiting the sample size and generalizability of results. Another limitation of this study was that only ACT Aspire Mathematics scores were used to compare the effectiveness of mathematics curriculums. No other achievement data was used in this study. A single form of high stakes standardized testing may not show a true representation of students' academic achievement due to outside factors such as behavior, test-taking abilities, and/or technology skills. Finally, the amount of time a student receives instruction in the specific curriculum being reviewed was not accounted for in this study.

Delimitations

A delimitation for this study was the focus was limited to grades three and four within the Guy- Fenter Educational Cooperative in Arkansas. ACT Aspire math scores were utilized as the main source of assessment data. A survey was conducted to determine the math curriculum utilized in schools across Arkansas. The data was collected from students who took the ACT Aspire in 2018-19.

Organization of the Study

Chapter 1 provided the background of the study as well as the purpose of the study, limitations, the significance of the study and key terms. Chapter 2 provides a review of the literature taking a deeper look into the history of mathematics instruction/curriculum in the US, accountability throughout history, standardized testing in Arkansas and current math curriculums utilized in Arkansas. Chapter 3 provides the methods utilized for the study including the participant information, research design and procedures for collecting the data. Chapter 4 will provide the data results from the research conducted in this study. Chapter 5 will discuss the results as well as the findings and recommendations for future research.

CHAPTER 2: REVIEW OF THE LITERATURE

Introduction

Although mathematics has been taught in schools for over 100 years, the public focus on mathematics has been limited to certain events. This literature review will focus on the following: (a) history of math instruction and curriculum in the US, (b) the accountability districts have faced throughout history, (c) standardized testing in Arkansas, and (d) curriculums currently used in Arkansas schools. The literature review contains information from peer-reviewed articles, educational databases, government reports, mathematic curriculum reports, and web-based educational journal articles.

Why Math Education?

Mathematics is found throughout history in various real-world issues such as time, money, recipes, and measurement. Mathematics is also needed for engineering, technology, and science as well as problem-solving and analytical reasoning. It has been an important part of the history of the United States; in colonial times, mathematics was needed for the mechanical aspect jobs in cities with businesses (Waggener, 1996). At the turn of the century, many college preparatory schools believed that training the mind on the most difficult subjects would prepare a person for any task (Waggener, 1996).

Schmidt, Houang and Cogan (2002) reported that data from the Third International Math and Science Study (TIMSS) determined that American teachers and students are at a great disadvantage due to our country's lack of a coherent math curriculum. A coherent curriculum is defined as a sequence of topics logically sequenced over time (Schmidt et al., 2002). Boaler and Zoido (2016) stated that the US uses memorization as part of their mathematical pedagogy more than other countries, but memorizers are the lowest achievers. Students using memorization were approximately six months behind students using relational strategies (Boaler & Zoido, 2016).

Many initiatives throughout the history of mathematics education tend to fail and later return with a new plan or program (Waggener, 1996). With little research on mathematics curriculum, this study focused on the effects of a mathematics curriculum on ACT Aspire mathematics scores among third and fourth grade students in Arkansas.

History of Math Instruction/Curriculum in the US

When formal education began, the focus was on literacy; however, mathematics was taught as a non-academic, skill subject (Waggener, 1996). Mathematics, originally known as arithmetic, was replaced with religion and reading by the Puritans in the Seventeenth century (Waggener, 1996). Arithmetic became a focus again in secondary schools during the early 1700's when it became a requirement for entrance in to college (Waggener, 1996).

Although arithmetic was taught in secondary schools, there was a gap in the number of teachers who were trained in mathematics to teach students at that level (Waggener, 1996). The following provides a review of the evolution of math instruction and curriculum in the US from the late 19th century to the present, which is imperative to this study because this study focuses on the effects of math curriculum to ACT Aspire mathematics scores.

Late 19th and early 20th century. Until the early 1800's, only boys attempted to learn arithmetic in a formal setting, while girls learned it through life experiences (Waggener, 1996). In the early 1800's, the first edition of *Warren Colburn's First Lessons in Arithmetic* became one of the most widely utilized textbooks because it focused on younger grades and taught students the skills needed to understand the operations (Waggener, 1996). Although arithmetic was taught in a formal setting, it was taught by having students memorize information and was not considered an important subject until early in the 20th century (Waggener, 1996). In the early 20th century, mathematics became known as the "standard of failure" in schools because so many students were lacking the needed skills leading to a need for change (Stanic & Kilpatrick, 1992).

One of the most influential leaders in mathematics education introduced what was considered the future of mathematics in the early 20th century (Klein, 2003). William Kilpatrick, a professor at Teachers College at Columbia University, who was mentored by John Dewey, was named the "Million Dollar Professor" by the New York Post because the number of students he taught throughout the years had paid more than a million dollars in fees (Klein, 2003).

Kilpatrick was a firm believer in progressive education as well as pedagogy (Klein, 2003). Kilpatrick believed that the drill method and mental math, which were both memorization methods, were not effective ways to teach mathematics (Klein, 2003). He also believed that algebra and geometry should not be required courses in high school (Klein, 2003). At the time, algebra was considered a subject with no value for at least 90% of boys and 99% of girls (Klein, 2003). This progressivist perspective was taken from Edward Thorndike's 1901 findings, which stressed that mathematical training did not transfer among subject areas, and that mathematics required repetitive practice as well as stimulus-response learning methods (Klein, 2003).

1923 Report. In the early 1920's, the Mathematical Association of America (MAA) released *The Reorganization of Mathematics for Secondary Education*, also known as the 1923 Report (Klein, 2003). The 1923 Report was the most comprehensive mathematics report written at that time (Klein, 2003). It included extensive secondary school curricula surveys and documentation of trainings provided to mathematics teachers in other countries (Klein, 2003).

The report focused on secondary school reorganization and curriculum development based on psychology and other education research (Waggener, 1996). The report also contradicted Kilpatrick by emphasizing the importance of algebra for every educated person (Klein, 2003). This report led to the founding of the National Council of Teachers of Mathematics (NCTM) by progressivist educators, which is still in practice today (Klein, 2003). The Report was due to the declining enrollment in secondary mathematics courses (Stanic & Kilpatrick, 1992). The declining enrollment led to some states not requiring mathematics classes in high school (Stanic & Kilpatrick, 1992).

The Activity Movement. The progressive education themes promoted by NCTM in the 1920s led to The Activity Movement of the 1930's (Klein, 2003). The goal of this movement was to integrate subjects at the elementary level (Klein, 2003). The curriculum would be determined by the teachers rather than the subject areas (Klein, 2003). Advocates of the Activity Movement disregarded reading and multiplication as legitimate instructional areas (Klein, 2003). High schools resisted this movement because teachers were trained to teach specific subject areas (Klein, 2003). Even mathematics courses, such as algebra, geometry, and trigonometry, were taught in insolation from one another (Stanic & Kilpatrick, 2004).

World War II. The US government sparked a new interest in mathematics education during World War II (Waggener, 1996) because new recruits in the army did not have the math skills needed for basic gunnery and bookkeeping (Klein, 2003). The largest effort at mathematics reform in the US took place during this time (Stanic & Kilpatrick, 2004). Although the need for restructuring the mathematics curriculum was present, reformers were reluctant to make changes to secondary mathematics courses (Stanic & Kilpatrick, 2004).

Life Adjustment Movement*.* In 1945, Dr. Charles Prosser's speech on vocational education given at a national conference mentioned "Life Adjustment." As a direct results of this speech, the US Education Commissioner appointed the Commission on Life Adjustment Education for Youth in 1947 (Janet, 1954).

Educational leaders were concerned that more than half of secondary school students would not be prepared for a skilled occupation, and secondary schools focused too much on an academic curriculum (Klein, 2003). The Life Adjustment Movement program created programs in schools to prepare students to live democratically and as a good citizen in society by focusing on life skills classes (Janet, 1954; Klein, 2003). The curriculum used for Life Adjustment education was founded on the belief that just because a program works in one school, it may not work in another school (Janet, 1954). The goal was to offer learning experiences that were individualized for each student in order to meet the needs of all students (Janet, 1954). During this time, the focus of mathematics courses included consumer buying, insurance, taxes, and budgeting rather than algebra, geometry or trigonometry (Klein, 2003). Schools continued to offer both types of classes to reach students who would go to college and students who would go straight into an occupation (Klein, 2003). Many mathematics teachers hired during this time lacked in training and depended on textbooks to teach (Miller, 1990).

Throughout the decade, advances in engineering and technology made changes to the economy; and by 1950 the public began to recognize the importance of academic-based mathematics courses (Klein, 2003). By 1950 less than 33% of students continued taking academic-based math courses in high school and less than that were not prepared for college (Miller, 1990). The public outcry caused the Life Adjustment Movement, as well as progressive education, to end (Klein, 2003).

New Math Movement. In the early 1950's, the "New Math" movement, or modern math movement, began in response to the advances in engineering and technology (Klein, 2003). Disagreements among various groups were overwhelming and sparked controversy over the way mathematics would be taught (Klein, 2003). The *Washington Post* published a story in which a chemist was frustrated over not understanding his child's math homework (Mathews, 1972).

The "New Math" movement introduced curriculum that combined comprehension and skills (Klein, 2003). The shifts in teaching included: (a) logical sequencing of topics and discussion, (b) removing topics that did not flow, (c) introducing a unified theme, and (d) using manipulatives to apply learning (Waggener, 1996). This was the first time in history that mathematicians contributed to K-12 math curriculum (Klein, 2003). The mathematicians argued that mathematics could be fun if it was taught through discovery and explaining the why, rather than through memorization (Miller, 1990).

In 1951, the University of Illinois Committee on School Mathematics (UICSM) was the first committee developed under the new math movement (Klein, 2003). The

UICSM created the first programmed textbook on probability and statistics for high school mathematics (Klein, 2003; Smithsonian Institute, n.d). The programmed textbooks were similar to regular textbooks; however, they focused on specific areas of mathematics and were much cheaper to print (Smithsonian Institute, n.d.). The textbooks were used on a trial basis in four schools before eventually becoming published for commercial use a few years later (Miller, 1990; Smithsonian Institute, n.d.; Miller).

Sputnik controversy. In 1957, Sputnik, the world's first artificial satellite, was launched into space by the Soviet Union, leading to a major controversy over mathematics and science education in the US (Klein, 2003). It was assumed the US would be the first nation to develop such a scientific advancement (Glass, 2018). In efforts to combat the controversy, the 1958 National Defense Education Act was signed into law by President Eisenhower, which gave funding to mathematics education programs (Waggener, 1996). A portion of this funding went to the School Mathematics Study Group (SMSG) in an effort to develop appropriate mathematics textbooks and a high school curriculum (Klein, 2003; Waggener, 1996). The SMSG was the largest and best-known committee project created to ensure science and mathematics research in America dominated research in other countries (Stanic & Kilpatrick, 2004). Other funding was used to pay off loans for students who were either going into a teaching career or a math or science related career (Glass, 2018).

The "New Math" movement continued in full force across the US, and by the end of the 1960's, more than three-fourths of all schools had adopted a form of the "New Math" curriculum (Miller, 1990). In the beginning, secondary school curriculum was the focus before moving down to the elementary level (Stanic & Kilpatrick, 2004).

Shortly after the beginning of the “New Math” movement, curriculum development shifted its focus to the federal government’s War on Poverty initiative (Stanic & Kilpatrick, 2004). Teachers and students were excited about the higher expectations that were developed within the initiative until they switched to schools that were considered “less advantaged” due to poverty and a shift in student race (Stanic & Kilpatrick, 2004). Mathematics textbook publications were in extreme demand with more than 600 different books used in all grades and schools across the country (Miller, 1990).

Although the new curriculum was crossing the country, many teachers were untrained and felt unprepared to teach it (Miller, 1990). As the “New Math” movement grew, so did various issues brought by public criticism. The public began criticizing the “New Math” movement by saying it was too confusing, impractical, and abstract (Stanic & Kilpatrick, 2004). Many blamed the movement for the lack of mathematical knowledge displayed in classrooms across the US (Miller, 1990). By the early 1970’s, funding dissipated and UICSM closed down (Miller, 1990).

Back to Basics. As the “New Math” movement ended, a Gallop Poll found that the public wanted more time spent on teaching basic skills (Gibney & Karns, 1979). The Back to Basics initiative was developed to address this public need by focusing on simple arithmetic skills in the classroom (Gibney & Karns, 1979). The US Government required “Back to Basics” programs to have accountability standards in order to receive federal funding (Waggener, 1996). These requirements led schools to teach using the “drill” methods rather than inquiry, or discovery, methods (Waggener, 1996). Drill methods included memorization through practicing number facts and skills repetitively (Ellis & Berry, 2005).

Political candidates rather than mathematicians or mathematic educators guided the “Back to Basics” movement (Gibney & Karns, 1979). Textbook companies switched gears and began printing skills-oriented textbooks (Ellis & Berry, 2005). Classroom teachers continued to choose the skills taught and the teaching methods used in the classroom with little to no alignment among what was being taught in other classrooms or among other schools (Gibney & Karns, 1979). Without alignment or curriculum standards, standardized test scores continued to decline (Klein, 2003).

In 1972, The National Institute of Education was established to improve education research (Woodward, 2004). Standardized assessment scores were used to measure the research conducted by the Institute (Woodward, 2004). The Institute sponsored The Missouri Mathematics Effectiveness Project, which focused on process-product research (Woodward, 2004). Process-product research is defined as the relationship between classroom teaching and student achievement outcomes (Woodward, 2004). The goal was to have elementary educators refine their understanding of basic skills instruction by moving the instruction from descriptive to experimental (Woodward, 2004). The Project correlated teaching behaviors to improved student performance on standardized assessments (Woodward, 2004). The Project described an effective mathematics teacher as one who had good management skills, practiced whole-class teaching, and taught lessons using a fast pace (Woodward, 2004). An effective teacher also used the active teaching model (Woodward, 2004). The four steps of the active teaching model were: (a) daily review, (b) development portion of the lesson, (c) independent seatwork, and (d) homework (Woodward, 2004).

Another federally funded research project completed by the Institute included comparisons between African American children living in poverty and children of higher socioeconomic classes (Woodward, 2004). This project led to the Johnson Administration's War on Poverty (Woodward, 2004). The War on Poverty focused on educational equality and provided legal protections

The 1980's reports. Two notable education reform reports, *An Agenda for Action* and *A Nation at Risk,* were released in the early 1980's (Klein, 2003). The National Council of Teachers of Mathematics (NCTM) first released *An Agenda for Action* recommending that the focus of mathematics education be on problem solving as well as new instructional methods (Klein, 2003). This report was overshadowed by the report, *A Nation at Risk,* which was written by a committee selected by President Ronald Reagan and chaired by US Secretary of Education Terrel Bell (Klein, 2003).

In the early 1980's Terrel Bell was given the primary mission of doing away with the US Department of Education by President Ronald Reagan (Mehta, 2015). In response to this mission, Bell formed the National Commission on Excellence in Education to report on the quality of education and suggestions for improvement (Mehta, 2015). Members of the committee did not agree with President Reagan's agenda to do away with the Department of Education and released the report *A Nation at Risk* to ensure that the President's agenda was impossible (Mehta, 2015).

A Nation at Risk outlined numerous education issues such as poor performance levels by the US when compared to other countries, high rates of illiteracy, and declining SAT scores over a 17-year span (Klein, 2003; Mehta, 2015). The report also focused on teacher quality, teacher shortages, textbook issues, high school course offerings including mathematics, and student assessment (Klein, 2003). The day following the release of *A Nation at Risk,* more than 400 copies were printed within an hour (Mehta, 2015). Within the following year, more than 600 million copies were printed (Mehta, 2015).

Although research disputes the findings of *A Nation at Risk*, it was and still is very influential in shaping educational legislation and policy (Good, 2010). The *A Nation at Risk* report led to a dramatic shift in mathematics education, including the creation of mathematics standards (Klein, 2003). Many states even created commissions to examine consistencies and deficiencies among their state educational program based on the *A Nation at Risk* recommendations (Klein, 2003).

NCTM released the *Curriculum and Evaluation Standards for School Mathematics* in 1989 leading to students learning how to make mathematical connections between concepts (Ellis & Berry, 2005). With the help from The National Science Foundation (NSF), NCTM promoted *The Standards* at the 1989 Education Summit attended by the state's governors and President Bush (Klein, 2003). This summit was the first attempt at national standards and accountability in the US (Walkling et al., 2014).

1990s to present. The first Bush administration (1988-1992) supported the NCTM standards in hopes for the US to become the top country in mathematics and science by the year 2000 (Klein, 2003; Woodward, 2004). NSF published two more documents as part of the NCTM standards (Klein, 2003). The first part was published in 1991 and focused on pedagogy; and the second part was published in 1995, which focused on testing (Klein, 2003). By this time, accountability through standardized testing was the focus in education reform and remains the focus today. Accountability is discussed in more detail in a later section of this chapter. The next section of this literature review will describe the various mathematics curriculums used in the Guy-Fenter Educational Cooperative.

Current Curricular Programs Utilized in Arkansas

In this study accountability was defined by the ACT Aspire mathematics scores to determine the effectiveness of different mathematics curricula. Although Arkansas has always allowed school districts to choose their own textbooks, ADE required school districts to adopt the textbooks and instructional materials as required by The Free Textbook Act of 1975. (Gewertz, 2015). The Free Textbook Act of 1975 allowed school districts to provide students textbooks and instructional materials free of charge (Act 511, 2013). The Act was repealed in 2013, and ADE no longer releases a list of textbooks nor are school districts in Arkansas required to adopt textbooks (Act 511, 2013).

In November 2018, the Guy-Fenter Educational Cooperative surveyed area schools to determine what math curricula are being taught. Half of the schools surveyed stated that their school was using Eureka Math or Engage NY as the math curriculum or resource. Other schools listed My Math, Math Expressions, Go Math, Saxon Math, and Investigations. Each of these curricula are described in more detail below.

Eureka Math. Based completely on CCSS, Eureka Math, or Engage NY, was developed a little over five years ago as part of Obama's Race to the Top initiative (Petrilli, 2017). Great Minds, a nonprofit organization, won the contract to create the free, online math curriculum first known as Engage NY, which was later renamed Eureka Math (Petrilli, 2017). As the curriculum was developed, the authors published it on their website, www.engageny.org, for all teachers to access free of charge with the goal of spreading the curriculum across the US. The curriculum consisted of approximately

50,000 pages for grades pre-kindergarten through twelve. The curriculum tells the story of mathematics in three sections: *A Story of Units* for grades Pre-k through five, *A Story of Ratios* for grades six through eight, and *A Story of Functions* for grades nine through twelve. These sections are sequenced into modules that build on one another.

A Story of Units is based on the three instructional shifts required by CCSS (Engage NY, 2014). The three shifts include focus, coherence, and rigor (Engage NY, 2014).

Each module in *A Story of Units* begins by introducing the module's clusters of standards from the Focus Grade Level Standards (Engage NY, 2014). Each topic contains a teaching sequencing chart showing how the material progresses and is aligned (Engage NY, 2014). Coherence is also demonstrated through the finite set of concrete and pictorial models throughout the grade levels (Engage NY, 2014). Rigor is displayed in *A Store of Units* through fluency, conceptual understanding, application and dual intensity (Engage NY, 2014). Fluency is part of the daily lesson structure, and students are expected to demonstrate speed and accuracy on the fluency activities (Engage NY, 2014). Conceptual understanding is defined as a deep understanding which can be communicated through the steps taken to solve a mathematical problem (Engage NY, 2014). During the application stage, students are able to apply the appropriate mathematical tool to solve problems (Engage NY, 2014). Dual intensity refers to the balance of application and conceptual understanding in the lesson structure (Engage NY, 2014).

The three components used in *A Story of Units* are designed to ensure effective, standards-based instruction with an emphasis on the creation, manipulation, and relationship between units, meaningful assessment, and engaging lessons (Engage NY, 2014). Rather than teaching through a spiral approach, *A Story of Units* teaches using a story-based approach with the basic building block, or unit, as the main character (Engage NY, 2014). The story progresses beginning with numbers to 10, then to addition and subtraction, place value, multiplication, fractions, and lastly word problems (Engage NY, 2014). Each lesson is structured to take approximately 60 minutes with instructional time utilized in the following components: (a) fluency practice, (b) concept development, (c) application problems, and (d) student debriefing (Engage NY, 2014). The lesson's at-a-glance gives the order of the components as well as the instructional time needed for each component (Engage NY, 2014).

My Math. The latest two mathematic curricular programs published by McGraw-Hill are My Math for grades K-5 and Reveal Math for grades 6-12. McGraw-Hill is one of the top five highest grossing textbook publishing companies in the US (Heitin, 2015). My Math was written after the release of CCSS and follows the scope set by CCSS (McGraw-Hill, n.d.).

This curricular program varies in cost based on the grade and number of students. On average, the cost for a class with 20 students is approximately $850.00 per year. The grade-level content follows the CCSS domains, and every chapter follows an Essential Question (McGraw-Hill, n.d.). My Math is based on focus, coherence, and rigor (McGraw-Hill, n.d.). McGraw-Hill (n.d.) defines focus as learning fewer concepts in each grade with the main concept being arithmetic and the measurement components required to support it. My Math demonstrates coherence by making progressions across the grade levels in order for students to build knowledge and make connections as they move across grades (McGraw-Hill, n.d.). As defined by CCSS, rigor contains the three aspects: (a) conceptual understanding, (b) fluency and (c) applications (McGraw-Hill, n.d.). McGraw-Hill (n.d.) states that all three of these aspects are balanced in the My Math curricular program to promote student learning. The lessons are structured to take approximately 60 minutes and include the following components: (a) Get Ready, (b) Investigate and Model, (c) Teach, (d) Practice and Apply, and (e) Wrap It Up.

Math Expressions. Math Expressions is the K-6 curricular program written by Dr. Karen Fuson and published by Houghton Mifflin Harcourt. Dr. Karen Fuson, a mathematics professor at Northwestern University, wrote Math Expressions based on research tasks found in her research *Children's Math Worlds* (Houghton Mifflin Harcourt, 2018).

Houghton Mifflin Harcourt is one of the top five highest grossing textbook publishing companies in the US (Heitin, 2015). The cost for this curricular program for a classroom of 20 students is approximately $2000.00-$2400.00 per year. Houghton Mifflin Harcourt (2018) states that Math Expressions is focused, coherent, rigorous, integrated, and balanced. Math Expressions is funded through National Science Foundation (NSF) and is based on CCSS. Math Expressions uses distributed practice consisting of phases of initial learning and then practicing to remember rather than a spiral approach (Houghton Mifflin Harcourt, 2018). Math Expressions focuses on priority core concepts at each grade level (Houghton Mifflin Harcourt, 2018). Progressions are identified through the Math Background listed in each unit's opening overview (Houghton Mifflin Harcourt, 2018). The lesson structure contains quick practice, student leaders, building concepts, math talk and helping community.

Go Math. Go Math is also published by Houghton Mifflin Harcourt. Go Math is a K-6 curricular program based on CCSS (Houghton Mifflin Harcourt, 2015). Go Math consists of the five "E" instructional strategies: Essential question, explore, explain, elaborate, and evaluate (Houghton Mifflin Harcourt, 2015). Go Math also focuses on writing and academic vocabulary with activities such as The Write Way, Vocabulary Builder, Math Journal, and Listen and Draw (Houghton Mifflin Harcourt, 2015). Go Math contains CCSS based learning progressions across the grades to ensure standards are being taught in a consistent manner (Houghton Mifflin Harcourt, 2015). The approximate cost for a classroom of 20 is $2400.00 per year plus an additional $2800 one-time fee for professional development training for teachers on how to implement the Go Math curriculum.

Saxon Math. John Saxon developed Saxon Math in the early 1980's (Saxon Math, n.d.). In 2005, Houghton Mifflin Harcourt started publishing Saxon Math (Saxon Math, n.d.). Saxon utilizes a comprehensive approach by breaking down the concepts in to smaller increments (Saxon Math, n.d.). Instruction, practice, and assessment are distributed throughout the lessons on a consistent basis to ensure students retain learned skills (Saxon Math, n.d.). Saxon is based on skills and objectives rather than CCSS or any state standards (Saxon Math, n.d.). The cost for a classroom set is approximately $1800.00 per year.

Investigations. Investigations, a K-5 mathematics curriculum developed by TERC and published by Pearson, is an inquiry-based program that allows students to investigate and solve mathematical problems (Pearson, 2017). Investigations is fully aligned to the CCSS (TERC, 2017). Investigations consists of the following guiding principles: (a) helping students develop mathematical ideas, (b) engaging teachers in ongoing learning about mathematics, and (c) collaboration among teachers and students based on the detailed agenda (TERC, 2017). The program uses multiple forms of assessments and provides differentiation for various student learners (TERC, 2017). The cost for a classroom set is approximately $1700.00 per year.

Ranking of Curricula. *Consumer Reports* completed a study on mathematics curricula, and it included the ones utilized by schools in the Guy-Fenter Education Cooperative. Three out of four curricula utilized in schools served by the Guy-Fenter Cooperative state that they are aligned with CCSS; however, in a *Consumer Reports* report, it was found that 17 out of 20 curricula reviewed were not aligned to CCSS for elementary students (Heitin, 2015).

The review panel consisted of 47 educators from across the US (Heitin, 2015). The panel reviewed the curricula on three gateways: (a) logical sequencing, (b) rigor and (c) usability (Heitin, 2015). Each gateway was rated using a three-tiered system: (a) meets criteria, (b) partially meets criteria and (c) does not meet criteria (Heitin, 2015). Math Expressions, published by Houghton Mifflin Harcourt, was rated partially meeting criteria for grades K-2 and not meeting criteria for grades 3-5 (Heitin, 2015). Six other Houghton Mifflin Harcourt curricula were also reviewed only partially meeting criteria for at least one grade level (Heitin, 2015). My Math, published by McGraw-Hill, did not meet criteria for kindergarten, partially met criteria for first and second grade, and met criteria for fourth and fifth grade (Heitin, 2015). Eureka Math was the only curriculum reviewed that met all criteria in grades K-5 (Heitin, 2015).

Gender in Mathematics

The purpose of this causal-comparative study was explore the relationship between math curricula, ACT Aspire Scores, and student gender in Arkansas among students in grades three and four. Math curricula were reviewed above; the next section of the literature review will focus on what is known regarding gender in mathematics learning.

As mentioned previously, only white males were allowed to take formal mathematics courses in the late 1800's and early 1900's (Waggener, 1996). Females have only been allowed to take mathematics courses in a formal setting for approximately 70 years (Neiderle & Vesterlund, 2010). Research gender achievement gaps did not start until the early 1970's after Title IV of the Civil Rights Act of 1964 was passed (Klein, 2003; United States Department of Justice, 2012). Title IV of the Civil Rights Act of 1964 prohibited elementary, secondary, and post-secondary schools from discriminating against students based on gender, race, religion, or origin (United States Department of Justice, 2012). Although both males and females have had mathematics courses as part of their education for nearly a century, according to the 2007 SAT math scores, the achievement gap between males and females scoring an 800 is at a 2:1 ratio (Neiderle & Vesterlund, 2010).

At first review, it appears some research indicates that there are not significant differences in math performance according to gender. For example, Ganley (2018) stated that younger students, under the age of nine, performed at the same level despite their gender. Two hundred and forty-one children ages three to seven years completed a computerized numerical comparison task and Weber fractions were calculated for each child (Ganley, 2018). Independent *t-tests* and Schuirmann's equivalence test showed that numerical representations were equal among boys and girls (Ganley, 2018). Similarly, Cimpian (2018) completed a study using data from the Early Childhood Longitudinal Study and found that there was no gender gap among kindergarten students; however, a gender gap of .25 standard deviation was found beginning in second grade. Some researchers believe that the gender gap exists because boys develop better spatial skills needed for mathematics at a younger age (Neiderle & Vesterlund, 2010).

Researchers also believe that the gender gap exists based on how males and females respond to the competitive aspect of mathematics (Neiderle & Vesterlund, 2010). An experiment completed at Technion in Israel selected 30 men and 30 women to compete in four different incentive schemes which required them to solve puzzles on the internet for 15 minutes (Neiderle & Vesterlund, 2010). When the schemes were competitive, the performance gender gap was 4.2 mazes; however, when the schemes were non-competitive, the performance difference was 1.5 mazes (Neiderle & Vesterlund, 2010). Azar (2010) interviewed Martha Carr, a psychologist from University of Georgia, about her study on first-graders which found that males are motivated by the competition by using their memory even if they are not accurate; whereas, females concentrate more on accuracy by relying on manipulatives. Girls may continue to use the manipulatives even if they know the answer (Azar, 2010). This strategy slows down students using manipulatives, causing them to become less fluent (Azar, 2010). Through observations during a study, Ganley (2018) found that females tend to have high levels of math anxiety and are less confident in their mathematic performances based on a study.

Ganley (2018) also found that the gender achievement gap became noticeable among high-performing students in high school and college. Ganley (2018) found that boys score higher on norm reference assessments, such as SAT. Kane and Mertz (2012) found that the gender achievement gap on the SAT among males and females scoring above 700 was 13:1 in the 1970's and 3:1 in the 1990's. The gender achievement gap was nearly eliminated on the ACT when all eleventh-grade students were required to take the exam (Kane & Mertz, 2012).

Azar (2010) stated that female student confidence and fluency may be influenced by their female teachers' math anxiety levels. In a 2010 study completed University of Chicago, it was found that nine out of 10 elementary teachers are female, and math anxiety ranks higher among elementary education majors than any other major (Azar, 2010). As the school year went on, researchers studied 52 boys and 65 girls in 17 first and second grade classes with female teachers and found that the more math anxiety displayed by teachers, the more girls believed they were not as good at math as boys causing their math scores to drop (Azar, 2010). This study also shows that elementary-aged children tend to emulate adults of the same gender causing the girls to sense their teachers' anxiety levels (Azar, 2010). Cimpian (2018) interviewed a small group of elementary teachers about their students' standardized test data. During this interview, the teachers rated the male student more mathematically inclined although both male and female students scored the same on a mathematics assessment (Cimpian, 2018). Based on the interviews, Cimpian (2018) made three points about teachers and gender bias in mathematics: (a) teachers tend to say that girls have to work harder than boys, (b) it is not known how to change this perception, and (c) many teachers use standardized assessments as evidence of not having a gender achievement gap.

Kane and Mertz (2012) completed a study using data from the 2003 TIMSS, the 2007 TIMSS and the 2009 PISA and found that a student's socioeconomic status correlated with the gender achievement gap through the Gender Gap Index (GGI). The three studies were compared using Pearson correlations (*r*) and regressions (Kane & Mertz, 2012). In 2007, the TIMSS fourth grade data showed a highly significant correlation (r=0.577; $p<0.001$) (Kane & Mertz, 2012). Female mathematics performance paralleled their quality job opportunities even if their family was wealthy (Kane & Mertz, 2012). When job mathematics-based job opportunities exist, females are more likely to take higher mathematics courses in high school and college to pursue those jobs (Azar, 2010). Through a 30-year longitudinal study with 5,000 male and female participants, Azar (2010) found that the number of males and females entering college for mathematics were nearly equal; however, more women changed their majors after starting college.

Conceptual Framework

The conceptual framework that informs this study is educational accountability. Educational accountability can be defined in numerous ways based on the underlying concepts of: (a) performance reporting: (b) a technical process, (c) a political process, and (d) an institutional process (Levin, 1974). Performance reporting is the most widely known accountability concept in education because it contains state-mandated assessments (Levin, 1974). The goal of the technical process is to correct any deficits that occur due to the performance reporting process (Levin, 1974). The purchase service from an educational contractor is the top use of the technical process (Levin, 1974). The political process refers to laws, acts, and mandates issued by the government as well as tax requirements to be used for schools (Levin, 1974). The operation and structure of the school is part of the institutional process (Levin, 1974).

All four concepts contain assumptions about educational accountability. It is assumed that information provided through performance reporting will be useful to the education field (Levin, 1974). The performance reporting concept also assumes that all laws, acts, and mandates are created to help schools reach their goals (Levin, 1974). It is assumed that educators based on standardized assessment results will demonstrate proficiency (Levin, 1974). For example, this assumption led California to create an accountability law known as the Stull Act, which allowed districts to terminate teachers who were not performing as expected (Levin, 1974). The political process assumes that education favors certain groups over others (Levin, 1974). The institutional process assumes that equity is provided for all students and all groups of students (Levin, 1974).

The educational accountability conceptual framework is most useful in informing the research questions for this study. Instructional standards and state-mandated assessments are two accountability measurements through the performance reporting concept utilized across districts in Arkansas. As mandated by ESSA, the Arkansas Department of Education (ADE) requires all students in grades three through eight and students in grade 10 take the ACT Aspire. ADE also requires all school districts to teach the Arkansas State Standards.

Schools are not required to use a specific curriculum to teach the standards, which is why it is important to research which curriculum is most effective as determined by

ACT Aspire math scores. Steiner (2017) reported that the Knowledge Matters Campaign found that a main factor of student academic success is the curriculum. The research question for this study examines math curricula by reviewing ACT Aspire math scores among students in grades three and four in Arkansas. Throughout history, education accountability has been based on various forms of assessments, and this chronology is detailed in the following section.

History of Education Accountability in the United States

Ellis and Berry (2005) stated that mathematics education in the US has been a revolving door for revisions under the basis of reform over the last century. Revisions are defined as adding new components that fit into the current plan, leading to surface level modifications (Ellis & Berry, 2005). Reform is defined as a transformation through core beliefs by restructuring how mathematics is taught and how mathematics is learned (Ellis & Berry, 2005).

Throughout the last century, reform efforts lacked in changing assessment methods and learning pattern outcomes (Ellis & Berry, 2005). Stanic and Kilpatrick (2004) reported that success efforts in education reform have been limited due to assessments linked to accountability requirements set forth by federal and local government as well as the textbook industry. The following provides a timeline of the history of the modern accountability movement in the US, starting with the National Defense Act in 1958 and ending with ESSA, the legislation signed into law in 2015 and is still governing educational accountability today.

Early foundations. One of the first reports published on mathematics was the Survey of American Education in 1908 by the International Commission on the Teaching of Mathematics (ICTM) (Waggener, 1996). The report found that over 80% of secondary schools did not offer higher mathematics courses (Waggener, 1996). In 1915, The National Education Association (NEA) asked William Kilpatrick, an education professor and progressivist, to study issues with teaching high school mathematics (Klein, 2003). This study was eventually included in the collection of reports, *The Reoganization of Mathematics for Secondary Education*, also known as the *1923 Report* (Klein, 2003). The Mathematical Association of America (MAA) also played an intricate part in the release of the *1923 Report*, which developed the first curriculum plan (Waggener, 1996). Neither of these reports discussed funding or accountability but did pave the way for accountability in mathematics.

National Defense Act. The National Defense Act was a reform effort developed in 1958 as a response to the launching of Sputnik (Waggener, 1996). The National Defense Act of 1958 stated that states and local schools must take over responsibility for public education; however, the security of the nation depended on the development of mental resources and technical skills (H.R. 13247, 1958). This was the first act passed by the government with funding attached to develop new math programs (Waggener, 1996). Title III of the Act (1958) allowed for states to receive funding to strengthen science, mathematics, and foreign language programs. In order to receive the funding, States had to create a plan meeting the following requirements:

- funding could only be spent on lab equipment, audio-visual materials and other printed materials besides textbooks in the listed areas;
- states must develop criteria for priority projects in the listed areas in the State;

- states must provide standards for each project in the listed areas (H.R. 13247, 1958).

Title V of the Act (H.R. 13247, 1958) allowed funding for aptitude testing. The Act required each state to submit a plan of how they would test secondary students to identify their aptitudes and how they would encourage these students to take courses based on the results of their aptitude testing (H.R. 13247, 1958). Section 1009 of the National Defense Act (H.R. 13247, 1958) addressed improvement of statistical information provided by State Educational Agencies. Funding was provided to States that developed a plan with the following requirements:

- improve collection, analysis and reporting of statistical data through local educational agencies;
- develop reporting manuals to be used as guides for local educational agencies;
- conduct trainings for local educational agency personnel on the evaluation of records;
- improve methods of collecting data from other state agencies;
- install mechanical equipment to process and report statistical data (H.R. 13247, 1958).

Elementary and Secondary Education Act of 1965. The Elementary and Secondary Education Act of 1965 (ESEA) was written in response to President Johnson's "War on Poverty" initiative (Paul, 2016). The goal of this act was to bring education to the forefront of poverty issues and give all students equal access to a quality education (Paul, 2016). ESEA required schools to follow set standards and accountability mandates to get federal funding, which could be spent on: (a) professional development, (b) instructional materials, (c) resources for educational programs, and (d) promoting parental involvement (Paul, 2016).

ESEA was first signed in to law on April 9, 1965 for five years, requiring a reauthorization from the government every five years afterward (Paul, 2016). Titles I-VI were created during the first three years of ESEA (Paul, 2016). Title I distributes more than 80% of the funding allocated for ESEA, causing it to receive the most attention from lawmakers (Paul, 2016).

Title I was developed to close the gap in literacy and mathematics for students living in poverty (Paul, 2016). Schools were eligible for Title I funding if a large portion of their student population was from low-income families (Paul, 2016). Title II provided funding for textbooks, school libraries and preschool programs (Paul, 2016). Title III provided special education services to rural school districts and summer educational programs (Paul, 2016). Title IV provided over $20 million each year for five years for education research and training (Paul, 2016). Title V provided state departments supplemental grants (Paul, 2016). Title VI provided the definitions and expectations of ESEA (Paul, 2016).

In 1969, President Richard Nixon amended ESEA, changing Title II and Title VI and adding Title VII and Title VIII (Paul, 2016). Title II provided funding for refugee children and children living in low-incoming housing (Paul, 2016). Title VI focused on the education of individuals with disabilities (Paul, 2016). Title VII focused on the Vocational Education Act of 1963 and Title VIII established Teacher Corps and defined gifted and talented (Paul, 2016). In 1972, other amendments were made including Title I giving protection to students against sex-based discrimination in schools (Paul, 2016).

Accountability in the 1980s and 1990s. During President Reagan's administration, Congress passed The Education Consolidation and Improvement Act (ECIA), reducing federal regulations for Title I funding by allowing states to determine how funding was spent (Paul, 2016). ECIA renamed Title I to Chapter I; however, most states continued with the same procedures (Paul, 2016).

With traditional Title 1 procedures continuing, The Hawkins-Stafford Elementary and Secondary School Improvement Act was developed in 1988 (Paul, 2016). This Act shifted the focus of Title I from the financial aspect to school improvement and student achievement (Paul, 2016). The act raised the standards for low-income students by raising the expected skill level from basic to advanced (Paul, 2016). Two other provisions were program improvements and school-wide projects (Paul, 2016). Program improvements required modifications for students who were receiving funding but were not showing improvements (Paul, 2016). School-wide projects changed the requirements for local funding to match school funding provided by Title I (Paul, 2016).

In 1993, the National Assessment of Title I detailed the lack of progress made with the Title I amendments throughout the 1980's (Paul, 2016). The assessment led to the 1994 Improving America's School Act (IASA), causing major revisions to ESEA (Paul, 2016).

IASA attempted to correlate federal resources with state and local level programs to improve instruction (Paul, 2016). There were three major changes made to Title I from IASA (Paul, 2016). First, mathematics and reading/language arts standards were added to assess student progress for accountability purposes (Paul, 2016). The second change allowed schools to implement school-wide programs at the 50% poverty level rather than the previously required 75% poverty level (Paul, 2016). Lastly, more local control was allowed giving schools the option to waive federal requirements if they interfered with school improvement plans (Paul, 2016).

Goals 2000. In 1994, President Clinton signed into law Goals 2000, setting eight educational goals to be accomplished by the year 2000 (Walkling et al., 2014). The National Center for Home Education (2002) listed the eight goals to be accomplished by 2000 as:

- students would start school ready to learn,
- the graduation rate would be 90 percent;
- students leaving grades four, eight and twelve would show proficiency in the assessed academic areas;
- teachers would be more qualified;
- the US would be first in math and science achievement;
- all adults would be literate;
- every school would be a gun free and violent free place; and
- schools would have an increase in parental involvement.

Although Goals 2000 was voluntary and was implemented in conjunction with ESEA, it came with strings such as improvement plans, penalties for not complying, and partnerships between public schools, colleges, and businesses for school-to-work programs (National Center for Home Education, 2002).

In 1999, the goals were reviewed by the National Education Goals Panel, who found that two goals on preschool education and student achievement showed improvement while two other goals on teacher quality and school safety showed deficiencies (National Center for Home Education, 2002). After President Bush released No Child Left Behind, Goals 2000 was terminated and funding was cut (National Center for Home Education, 2002).

No Child Left Behind. President Bush reauthorized ESEA in 2002 as the *No Child Left Behind Act,* which ushered in the current educational accountability movement. (NCLB; Walkling et al., 2014). The National Center for Learning Disabilities (n.d.) identified the four main goals of NCLB were to: (a) ensure stronger accountability, (b) increase local control, (c) expand parent options, and (d) emphasize teacher qualifications.

NCLB held schools accountable through state assessments, which focused on academic standards taught in the classroom (National Center for Learning Disabilities, n.d.). NCLB covered the same topics as Goals 2000 but at a deeper level, and it set proficiency levels for standardized testing (Walkling et al., 2014). However, states were still responsible for creating their own set of educational standards (Walkling et al., 2014).

Many argued that with all states having their own set of standards, proficiency levels would be lowered to meet federal requirements (Walkling et al., 2014). This concern led to an even greater push for national standards (Walkling et al., 2014). Under NCLB, schools were required to publish annual report cards detailing student achievement and demographics (Paul, 2016). Schools were also held accountable if they failed to meet Adequate Yearly Progress (AYP) via monitoring through the State Department of Education or lose funding, as determined by Title I (Paul, 2016).

Race to the Top. Race to the Top, an education reform program under President Obama, was one of the largest reform initiatives created by a president to change the education system in the US (Howell, 2015). The focus of Race to the Top was to align state education policies with college readiness objectives (Howell, 2015).

Race to the Top was part of a larger plan known as the American Recovery and Reinvestment Act of 2009 (ARRA), which President Obama signed into law (Howell, 2015). ARRA granted over $4 billion of the $100 billion set aside for education to the Race to the Top initiative (Howell, 2015). As part of Race to the Top, states competed for a portion of the $4 billion by developing plans to address the following four areas: (a) standards and assessments, (b) teacher evaluation, (c) teacher and leader support, and (d) intervention (Klein, 2014).

In the three phases, points were awarded to states in six categories: (a) state success factors, (b) standards, (c) data systems, (d) quality teachers, (e) school turn-around, (f) innovative ideas, and STEM (Howell, 2015). Only 10 states did not submit applications for phase one (Howell, 2015). Tennessee and Delaware were the winners of phase one and were awarded with approximately $620 million (Howell, 2015). Only 35 states applied for phase two, but this phase had 10 states who were awarded amounts ranging from $75 million to $700 million (Howell, 2015). Only the losing states from phase two were allowed to apply for phase three (Howell, 2015). Congress had to find funding for phase three because, by this point, ARRA funding was drained (Howell, 2015). Even with funding issues, seven states were awarded amounts ranging from $17 million to $43 million (Howell, 2015). Many states adopted policies and education reforms in efforts to make their applications more competitive (Howell, 2015).

Common Core State Standards. Common Core State Standards (CCSS) were developed as part of the Race to the Top initiative (Walkling et al., 2014). The focus of CCSS was to ensure that all students would be college and career ready (Walkling et al., 2014). CCSS were developed for literacy (including reading, writing, and speaking/listening) and mathematics (Walkling et al., 2014).

The CCSS for mathematics focused on elementary arithmetic and the surrounding components similar to NCTM standards; however, less topics were covered (Center for Elementary Mathematics and Science Education, n.d.). The CCSS for math led to three shifts in math instruction: (a) focus, (b) coherence, and (c) rigor. Focus refers to the limited scope of content to be taught in each grade with the intent to dig deeper into each standard. Coherence refers to the connections students are able to make in mathematics within and across the grade levels. Rigor refers to the application, understanding, and fluency of the standard. With less standards, teachers can cover the material at a deeper level, giving students an opportunity to master the standard (Center for Elementary Mathematics and Science Education, n.d.). In the beginning, only four states chose not to adopt the CCSS (Walkling et al., 2014).

Arkansas adopted the CCSS initially; however, CCSS came with a political stigma and much public backlash. In effort to stay out of the media limelight, Arkansas created the Arkansas State Standards in 2017, which were parallel to the CCSS. According to Ujifusa (2017), 11 states including Arkansas created their own standards correlating to CCSS or replacing CCSS.

Every Student Succeeds Act. ESEA and NCLB were reauthorized as Every Student Succeeds Act (ESSA) on December 10, 2015 under President Obama's administration (Paul, 2016). Although ESSA allowed flexibility at the state level, states had to adopt college and career-ready standards, implement accountability focusing on the lowest-performing schools, and implement teacher and principal evaluation systems (Paul, 2016).

The purpose of ESSA was to ensure student achievement especially for students in poverty, minority students, special education students, and English Language Learners (Lee, n.d.). States were required to choose five indicators for accountability. The four mandatory indicators were: (a) academic achievement, (b) academic progress, (c) English language proficiency, and (d) high school graduation rates (Lee, n.d.). States could choose the fifth indicator from the following: (a) kindergarten readiness, (b) completion of advanced coursework, (c) college readiness, (d) discipline rates, and (e) chronic absenteeism (Lee, n.d.).

States were also required to develop district and school report cards consisting of: (a) test score results, (b) high school graduation rates, (c) school funding information, and (d) teacher qualifications (Lee, n.d.). The 2017-18 school year was the first year to experience the impact of ESSA via the new format of an individual state's report card requirements for each school district (Lee, n.d.).

Accountability and Standardized Testing in Arkansas

Accountability began in Arkansas during the 1980's under the administration of President Ronald Reagan (Arkansas Bureau of Legislative Research, 2017). In 1994, under President Clinton's administration, accountability plans, which included state standards, were developed in Arkansas (Walkling et al., 2014). The three main accountability efforts focused on in this study include (a) Minimum Competency Testing,

(b) Arkansas Comprehensive Testing, Assessment and Accountability Program, and (c) Act 930.

Minimum Competency Test. The first attempt to hold schools accountable in Arkansas was in 1983 when the Arkansas Supreme Court determined that the state's funding system did not provide students with equal educational opportunities in *DuPree v. Alma School District No. 30* (Arkansas Bureau of Legislative Research, 2017). During this same year, Act 54 was passed under Governor Bill Clinton, requiring schools to be held accountable for student mastery of basic skills (Arkansas Bureau of Legislative Research, 2017). The Arkansas Department of Education (ADE) chose to administer the Minimum Competency Test to students in grades three, six, and eight to measure mastery of basic skills primarily in mathematics, reading, and language; schools were required to have at least 85% of students pass the test or enter into an improvement plan through ADE (Arkansas Bureau of Legislative Research, 2017).

Arkansas Comprehensive Testing, Assessment and Accountability Program. In 1999, under Governor Mike Huckabee, Act 999 was passed, which created the Arkansas Comprehensive Testing, Assessment and Accountability Program (ACTAAP). ACTAAP required elementary and middle school students to be assessed and demonstrate proficiency in literacy and math (Arkansas Bureau of Legislative Research, 2017). ACTAAP also required eleventh grade students to be assessed in literacy as well as algebra and geometry end-of-course exams (Arkansas Bureau of Legislative Research, 2017). Arkansas continued to use the ACTAAP assessments to meet the assessment requirements of NCLB (Arkansas Bureau of Legislative Research, 2017).

In order to compare Arkansas student performance with student performance across the nation, Arkansas started assessing students using the Iowa Test of Basic Skills (ITBS), which was later combined with the Benchmark Assessment in an effort to reduce the amount of time spent on student testing (Arkansas Bureau of Legislative Research, 2017). In 2013, ACTAAP replaced the Benchmark Assessment with the Partnership for Assessment of Readiness for College and Career (PARCC) due to too many students not showing proficiency on the Benchmark Assessment (Arkansas Bureau of Legislative Research, 2017). The PARCC was replaced with ACT Aspire after only one year (Arkansas Bureau of Legislative Research, 2017). The ACT Aspire became the state's accountability assessment tool starting in 2016 (Arkansas Bureau of Legislative Research, 2017).

Act 930. In 2017, Act 930 replaced ACTAAP with Arkansas Educational Support and Accountability Act (AESAA) in order to meet the federal requirements for Every Student Succeeds Act (ESSA; Arkansas Bureau of Legislative Research, 2017). Through the AESAA, Arkansas State Standards were created for literacy and math, and Next Generation Science Standards were adopted for Science replacing CCSS (Arkansas Bureau of Legislative Research, 2017). Students in grades 3-10 continued to be assessed using ACT Aspire (Arkansas Bureau of Legislative Research, 2017). This act also required all schools to put systems in place to support educator effectiveness by reporting teacher qualifications and limiting the number of inexperienced educators as well as educators on an Alternative Licensure Plan (ALP; Arkansas Bureau of Legislative Research, 2017).

Act 930 also requires schools to utilize a student-focused learning model to assess individual student performance and to determine individual student needs (Arkansas Bureau of Legislative Research, 2017). Beginning in the 2019-20 school year, the data from student performance will be utilized to create a student success plan for every student entering eighth grade (Arkansas Bureau of Legislative Research, 2017).

Research Questions and Hypotheses

Based on the conceptual framework of educational accountability and the information gathered in the literature review, this study explored the following research questions and hypotheses:

- RQ1: What effect, if any, does a math curriculum have on third and fourth grade ACT Aspire math scores in Arkansas?
    - H1: There will be no significant difference between third and fourth grade ACT Aspire math scores based on math curriculum.
- RQ2: How do demographic factors combined with curriculum affect third and fourth ACT Aspire math scores?
    - H2: Math curriculum and gender have a combined effect on third and fourth grade ACT Aspire math scores.
    - H3: Math curriculum and student grade level will have a combined effect on third and fourth grade ACT Aspire math scores.
    - H4: Student grade level and gender will have a combined effect on third and fourth grade ACT Aspire math scores.

Summary

The literature review for this quantitative study began with a brief explanation of why mathematics is important (Boaler & Zoido, 2016; Schmidt et al., 2002; Waggener, 1996) followed by a detailed history of mathematics instruction and curriculum in the US. The detailed history of mathematics instruction/curriculum in the US begins in the 1700's (Waggener, 1996) and continues through today (Ellis & Berry, 2005; Gibney & Karns, 1979; Good, 2010; Glass, 2018; Janet, 1954; Klein, 2003; Mathews, 1972; Mehta, 2015; Miller, 1990; Stanic & Kilpatrick, 1992; Smithsonian Institute, n.d.; Walkling et al., 2014; Woodward, 2004). The detailed history also discusses The Activity Movement (Klein, 2003), The Life Adjustment Movement (Janet, 1954; Klein, 2003; Miller, 1990), the New Math Movement (Klein, 2003; Mathews, 1972; Smithsonian Institute, n.d.), and the Back-to-Basics Movement (Gibney & Karns, 1979; Klein, 2003; Waggener, 1996) which were all linked to education reforms in mathematics.

Following the detailed history of mathematics instruction/curriculum in the US, current curricular programs utilized in Arkansas are discussed (Act 511, 2013; Gewertz, 2015). The current curricular programs include Eureka Math (Engage NY, 2014; Petrilli, 2017), My Math (Heitin, 2015; McGraw-Hill, n.d.), Math Expressions (Heitin, 2015; Houghton Mifflin Harcourt, 2018), Go Math (Houghton Mifflin Harcourt, 2015), Saxon Math (Saxon Math, n.d.), and Investigations (Pearson, 2017; TERC, 2017). The relationship between the curriculum programs and ACT Aspire mathematics scores is also noted.

The literature review also discusses gender in mathematics and the history of how gender played a part in the history of mathematics (Klein, 2003; Neiderle & Vesterlund, 2010; United States Department of Justice, 2012; Waggener, 1996). This portion of the literature review also discusses researchers' philosophies on why the gender gap may exist based on brain development and competitive skills (Azar, 2010; Cimpian, 2018; Ganley, 2018; Kane & Mertz, 2012; Neiderle & Vesterlund, 2010).

The literature review concludes with a detailed explanation of accountability as the conceptual framework (Levin, 1974; Steiner, 2017), including the history of accountability (Ellis & Berry, 2005; Klein, 2003; Stanic & Kilpatrick, 2004; Waggener, 1996), accountability and standardized testing in Arkansas (Arkansas Bureau of Legislative Research, 2017), and the research questions guiding the study.

Chapter 3 will describe the methods utilized to complete the study, including the research questions and hypothesis, research design, participants, sampling, data collection, instrument, and data analysis.

CHAPTER 3: METHODOLOGY

Introduction

This chapter outlines the methodology used in this study. The purpose of this causal-comparative study was explore the relationship between math curriculums, ACT Aspire Scores, and student demographics in Arkansas among students in grades three and four. This chapter will take a deeper look into the participants, sampling, the research method, procedures, measurement, statistical analysis, and research ethics for the study.

Research Questions and Hypotheses

The research questions and hypothesis explored in this study are as follows:

- RQ1: What effect, if any, does a math curriculum have on third and fourth grade ACT Aspire math scores in Arkansas?
    - H_o1: There will be no significant difference between third and fourth grade ACT Aspire math scores based on math curriculum.
- RQ2: How do demographic factors combined with curriculum affect ACT Aspire math scores?
    - H2: Math Curriculum and gender have a combined effect on third and fourth grade ACT Aspire math scores.
    - H3: Math Curriculum and student grade level will have a combined effect on third and fourth grade ACT Aspire math scores.
    - H4: Student grade level and gender will have a combined effect on third and fourth grade ACT Aspire math scores.

Research Design

This study utilized a quantitative, causal-comparative research method to examine the relationship between math curriculums and ACT Aspire Math Assessment scores between third and fourth grade students located in the Guy-Fenter Education Cooperative. Quantitative research methods are defined as collecting and analyzing numerical data to explain the results of a study (Salkind, 2010). Salkind (2010) defines the causal-comparative design as one that explores relationships between dependent and independent variables after the occurrence of the event. This study is quantitative because the researcher utilized numerical data collected from ACT Aspire to complete the study. The study is causal-comparative because the researcher reviewed the ACT Aspire scores to determine which of the curriculums already in use by the schools were most effective based on higher ACT Aspire math scores. This method was chosen because statistical data to be used was created after the curriculum was taught.

For accountability purposes, the Arkansas Department of Education (ADE) requires all school districts to administer the ACT Aspire to measure student and school progress (Arkansas Bureau of Legislative Research, 2017). Although ADE does not require school districts to adopt a curriculum, school districts are required to provide instruction based on the Arkansas State Standards.

For this study, schools were surveyed to determine the math curriculum used for instruction. Individual third and fourth grade student ACT Aspire math scores (the dependent variable in this study) were collected through the ADE Data Center. The independent variables for this study were the math curriculum used by the school, student grade, and student gender; all data for these variables were provided by the school district and the ADE Data Center. This study followed all rules and regulations regarding research ethics and received approval from the Arkansas Tech University IRB (See Appendix) prior to recruitment or collection data.

Participants

The participants in this study were third and fourth grade students who took the ACT Aspire Math Assessment from 21 school districts in the Guy-Fenter Education Cooperative. School districts in the Guy-Fenter Education Cooperative that were asked to participate in this study are Alma, Booneville, Cedarville, Charleston, Clarksville, County Line, Fort Smith, Greenwood, Hackett, Lamar, Lavaca, Magazine, Mansfield, Mountainburg, Mulberry/Pleasant View, Ozark, Paris, Scranton, Van Buren, Waldron, and Westside.

Sampling

This study used a convenience sampling approach to compare ACT Aspire Math scores between third and fourth grade students from Guy-Fenter Education Cooperative Schools in Arkansas. Convenience sampling is a form of non-probability sampling that involves selecting participants who are within reach or are readily available (Taherdoost, 2016). Non-probability samples do not have to be random, but a clear explanation of why certain groups were chosen must be provided (Taherdoost, 2016). Convenience sampling was the best fit for this study because the schools chosen to participate are located within the Guy-Fenter Education Cooperative area and work closely with one another through the Guy-Fenter Education Cooperative. Selection of schools was based on a willingness to participate, grade levels within the school, and location within the Guy-Fenter Education Cooperative area.

Guy-Fenter Education Cooperative consists of 21 school districts in the western central region of Arkansas: Alma, Booneville, Cedarville, Charleston, Clarksville, County Line, Fort Smith, Greenwood, Hackett, Lamar, Lavaca, Magazine, Mansfield, Mountainburg, Mulberry/Pleasant View, Ozark, Paris, Scranton, Van Buren, Waldron, and Westside. Table 1 shows the demographic information for each school.

Table 1

Guy-Fenter Educational Cooperative School Districts Enrollment with Student Gender

		Gender	
School District	Total Enrollment	M	F
Alma	3244	1648	1596
Booneville	1183	612	571
Cedarville	745	371	374
Charleston	902	437	465
Clarksville	2530	1296	1234
County Line	488	242	246
Fort Smith	14119	7248	6871
Greenwood	3778	1932	1846
Hackett	756	387	369
Lamar	1359	664	695
Lavaca	820	438	382
Magazine	520	244	276
Mansfield	779	409	370
Mountainburg	615	326	289

Mulberry/Pleasant View	410	216	194
Ozark	1789	964	825
Paris	1029	543	486
Scranton	424	220	204
Van Buren	5732	2881	2851
Waldron	1435	780	655
Westside	634	329	305

Note. Adapted from "Enrollment by Race & Gender by District," by ADE Data Center, 2019.

Two of the districts, Van Buren and Fort Smith, consist of more than one school that houses third and fourth grades. All districts within the Guy-Fenter Educational Cooperative were invited to participate in the study. The school districts, along with their contact information, are listed on the Guy-Fenter Educational Cooperative website. Schools housing third and fourth grade were first contacted through an email surveying their willingness to participate in the study. Schools that did respond to the email survey within a week received a follow-up phone call survey. Superintendents who responded stating they were willing to participate were asked in writing to provide permission for the researcher to request individual ACT Aspire math data for individual students in third and fourth grade from the ADE Data Center. Schools were then called to determine the math curriculum utilized during the 2018-19 school year. Table 2 shows the third and fourth grade student enrollment for each district in the Guy-Fenter Educational Cooperative.

Table 2

Guy-Fenter Educational Cooperatives Districts Enrollment for Third and Fourth Grades

School District	3rd Grade Enrollment	4th Grade Enrollment
Alma	245	224
Booneville	93	96
Cedarville	49	53
Charleston	64	73
Clarksville	208	222
County Line	40	46
Fort Smith	1148	1096
Greenwood	283	285
Hackett	43	55
Lamar	98	103
Lavaca	54	63
Magazine	39	36
Mansfield	48	57
Mountainburg	49	39
Mulberry/ Pleasant View	45	30
Ozark	127	146
Paris	78	63
Scranton	32	45
Van Buren	471	476
Waldron	102	120
Westside	47	53

Note. Adapted from "Enrollment by Grade by School" by ADE Data Center, 2019.

Data Collection

For this study, data on math curriculum was collected through a phone survey. Individual student score data and student demographic information was collected through the ADE Data Center. Each data collection method is described below.

Survey to determine math curriculum. The researcher requested permission in writing from each district's Superintendent to secure their district's participation in the study. Schools with grades three and four within the Guy-Fenter Education Cooperative were surveyed through a phone call. The survey asked one question:

1) What was the math curriculum utilized for instruction for third and fourth grades during the 2018-19 school year?

The researcher recorded the data on a table created through Microsoft Word. The table was saved on the researcher's laptop. The follow-up phone calls were directed to the building level principal or instructional facilitator.

ACT Aspire and student demographic data. Individual ACT Aspire math scores and demographic data (including grade level and gender) for third and fourth graders was provided to the researcher from the ADE Data Center. The researcher requested that student names and school ID numbers were removed to ensure confidentiality of each student remained intact. The researcher requested the data be sent via email.

Instrument

The measure for the dependent variable in this study—ACT Aspire math scores—was the ACT Aspire exam. The details of this measure are provided below.

ACT Aspire. ADE required all schools to administer the ACT Aspire Assessment to students in grades 3-10 beginning in the 2015-16 school year in order to be compliant with the accountability requirements of ESSA (Arkansas Bureau of Legislative Research, 2017). The ACT Aspire assesses students in grades 3-10 in the following five subject areas: English, mathematics, reading, science, and writing (ACT, 2019). Because this study focuses on math scores, the only subject area included in this study is the ACT Aspire Math Assessment. The ACT Aspire mathematics assessment is a computer-based assessment in Arkansas; however, the assessment is also offered as a paper assessment (ACT, 2019). The ACT Aspire mathematics assessment consists of various types of questions such as multiple choice, constructed response, and technology enhanced questions in nine reporting categories with five of the categories reported in grades three and four (ACT, 2019). The five categories of math skills covered on the test for students in grades three and four are: (a) Number & Operations in Base 10, (b) Number & Operations-Fractions, (c) Operations & Algebraic Thinking, (d) Geometry, (e) and Measurement & Data (ACT, 2019). These categories are guided by what should be taught based on grade-level Common Core State Standards (CCSS) (ACT, 2019).

Number & Operations in Base 10 are covered in CCSS for grades kindergarten through five (ACT, 2019). Students should know place-value connections fluently and be able to explain their reasoning (ACT, 2019). Numbers & Operations-Fractions are taught in grades three through five (ACT, 2019). Students should be able to explain the steps of fraction computation procedures (ACT, 2019). Operations & Algebraic Thinking CCSS are covered in grades kindergarten through five (ACT, 2019). The goal of this standard is for students to utilize and explain all four operations fluently (ACT, 2019). Geometry is covered in grades kindergarten through early high school (ACT, 2019). In grades three through five, students should be able to categorize shapes based on attributes (ACT, 2019). Measurement & Data CCSS are covered in grades kindergarten through five (ACT, 2019). Students should be able to solve problems involving units, conversions, measurement and time (ACT, 2019).

ACT Aspire also reports on the mathematical practices, Justification & Explanation and Modeling, in conjunction with the five categories (ACT, 2019). Justification & Explanation utilizes a construct-response format to directly measure how a student functions in applying mathematical practices to a problem (ACT, 2019). Students should be able to read, understand and respond to a problem as part of a Justification & Explanation task (ACT, 2019). Problems involving interpreting, producing, evaluating and predicting are part of the Modeling category (ACT, 2019). Table 3 details the ranges by item and raw score points for grades three through five.

Table 3

Specification Ranges by Item Type and Reporting Category for Grades 3-5

Operation Types	Number of Items	Raw-Score Points
Item Types		
Multiple Choice	17-20	17-20 (46-54%)
Technology Enhanced	1-4	1-4 (3-11%)
Constructed Response	4	4 (43%)
Reporting Categories		
Grade Level Progress	17	23 (62%)
Numbers & Operations in Base 10	3-4	3-4 (8-11%)
Numbers & Operations-Fractions	3-4	3-4 (8-11%)

Operations & Algebraic Thinking	3-4	3-4 (8-11%)
Geometry	3-4	3-4 (8-11%)
Measurement & Data	3-4	3-4 (8-11%)
Foundation	8	14 (38%)
Justification & Explanation	4	16 (43%)
Modeling	>12	>12 (>48%)
Depth of Knowledge		
DOK Level 1	3-5	3-5 (8-14%)
DOK Level 2	11-13	11-13 (30-35%)
DOK Level 3	8-10	20-22 (54-59%)
Non-Operational Items		
Field-Test	3-6	---
Total	28-31[a]	37 (100%)

Note. [a]Total number of items contains field-test items that do not contribute to score points. Adapted from "The ACT Technical Manual," by ACT, 2019.

The raw scores are converted into scale scores to report student performance (ACT, 2019). The three-digit composite scores begin at 400 and move upward (ACT, 2019). The longitudinal scale used as part of the scale scores collects data from students within the same grade level to provide a direct comparison (ACT, 2019). Student scores on the ACT Aspire Math Assessment are broken down into four categories: (a) exceeding, (b) ready, (c) close and (d) need of support (ACT, 2019). Students scoring ready or exceeding are considered to be meeting grade level expectations (ACT, 2019). Table 4 shows the scale score system used by ACT Aspire for mathematics in grades three and four.

Table 4

ACT Aspire Scale Scores

Grade Tested	Subject	Low Score	High Score	Benchmark
3	Mathematics	400	434	413
4	Mathematics	400	440	416

Note. Adapted from "The ACT Technical Manual," by ACT, 2019.

Reliability for ACT Aspire Math. The consistency of test scores is estimated by reliability coefficients (ACT, 2019). Reliability coefficients usually range between zero and one (ACT, 2019). When the value is closer to one, the consistency is greater; however, when the value is closer to zero, there is little to no consistency (ACT, 2019). Inconsistency or errors in scores are stated in the standard error of measurement (SEM) (ACT, 2019).

Raw score reliability on the ACT Aspire is reported using Cronbach's coefficient alpha (ACT, 2019). The coefficient alpha was also checked by calculating the stratified coefficient alpha and congeneric reliability coefficients (ACT, 2019). The values for all three coefficients were equal in comparison on every grade level's ACT Aspire assessments in each subject area (ACT, 2019). The raw score reliabilities from 2013 and 2014 showed that the Mathematics reliability in fourth grade was low; however, the score did slightly increase on the 2014 assessment (ACT, 2019). Score consistency can be determined through raw score reliabilities, but raw scores are not used to determine student performance (ACT, 2019). Table 5 displays the raw score reliability coefficient ranges for Mathematics in grades three and four.

Table 5

ACT Aspire Raw Score Reliability Coefficient Ranges

Grade Tested	Subject	2013	2014
3	Mathematics	.73-.79	.78-.79
4	Mathematics	.55-.76	.67-.68

Note. Adapted from "The ACT Technical Manual," by ACT, 2019.

The unidimensional item response theory (IRT) model framework was used to develop the ACT Aspire scale score (ACT, 2019). The IRT model estimates the scale score reliabilities and conditional SEM through statistical models (ACT, 2019). Scale score reliabilities are preferred because they estimate the reported student scores (ACT, 2019). All five of the following subject areas receive a scale score: English, mathematics, reading, science, and writing (ACT, 2019). In addition, combined scores are reported in the areas of Composite, ELA and STEM (ACT, 2019). The Composite score consists of averaging together the English, mathematics, reading and science scale scores (ACT, 2019). The ELA score consists of the English, reading, and writing scale scores averaged together (Act, 2019). The STEM score consists of averaging the mathematics and science scale scores (ACT, 2019). Table 6 shows the scale score reliability coefficient and SEM in Mathematics for grades three and four in 2014.

Table 6

ACT Aspire Scale Score Reliability Coefficient and SEM in 2014

Grade Tested	Subject	Reliability	SEM
3	Mathematics	.80	1.82
4	Mathematics	.67	2.34

Note. Adapted from "The ACT Technical Manual," by ACT, 2019.

Validity for ACT Aspire Math. ACT (2019) defines validity as the degree of support needed for proposed uses of score interpretations. The interpretations of ACT Aspire scores are numerous and are not able to be fully validated in the ACT technical manual (ACT, 2019). ACT Aspire categorizes evidence for validity into the following six areas: (a) content-oriented evidence, (b) cognitive process, (c) internal structure, (d) relationships to other constructs, (e) relationships with criteria and (f) consequences (ACT, 2019). The two primary interpretations for student readiness are college ready and career-ready (ACT, 2019). The three secondary interpretations are providing educators: (a) information for instructional purposes, (b) accountability inference data, and (c) international comparison inference support (ACT, 2019). Uses of individual student ACT Aspire scores include: (a) reviewing student proficiency, (b) reviewing student growth, (c) predicting future performance, (d) student diagnostic information, and (e) ranking students (ACT, 2019). Uses for aggregate ACT Aspire data include reviewing school accountability, school and classroom growth, and evaluating the impact of a curriculum (ACT, 2019). ACT (2019) states that some of these interpretations may align more closely than others and should be evaluated thoroughly (ACT, 2019).

Content-Oriented Evidence. Content-Oriented validity evidence in the ACT Aspire is based on the procedures used to develop test content (ACT, 2019). ACT Aspire bases their reasoning on connections found within the following six areas: (a) content domain, (b) knowledge and skills, (c) development of items, (d) development of forms, (e) test administration conditions and (f) item/test scoring (ACT, 2019). Testing items are developed using templates by item writers, who are chosen from a group of educators (ACT, 2019). Items are pretested by students within the potential ACT Aspire testing population to ensure accuracy (ACT, 2019). The ACT Aspire can be administered on paper or online (ACT, 2019). Both methods contain time limits and are expected to be administered in the same manner (ACT, 2019).

Cognitive Process. Cognitive process validity evidence consists of two sources: constructing responses and rating student responses (ACT, 2019). Constructing responses refers to students thinking aloud as they process a test item (ACT, 2019). This process gathers information to determine whether the intended response is consistent with the response given by the student (ACT, 2019). Rating student responses refers to the process used by raters to ensure the accuracy of the interpretations to student responses (ACT, 2019). Raters use rubrics, rules, and specific criteria during this process to ensure the response scores are valid (ACT, 2019).

Internal Structure. ACT (2019) defines internal structure as the interpretations between the intended score and the expected characteristics. Mathematics scores are expected to be unidimensional based on the 2013 compatibility study data; however, a two-factor model was the best fit for analyzing the data (ACT, 2019). This was more evident in the grade four and five mathematics paper assessment as well as the grade six online assessment (ACT, 2019). It was determined that grades four and six ACT Aspire mathematics assessment may require additional monitoring in the future to determine whether a second dimension is evident (ACT, 2019).

Relationships to Other Constructs. Relationships to other constructs refers to comparing test item scores to other variables (ACT, 2019). Studies were conducted to compare ACT Aspire scale scores to other similar construct assessment scores (ACT, 2019). Other assessments compared to the ACT Aspire were ACT Explore and ACT Plan (ACT, 2019). The grade levels compared were grades eight to ten (ACT, 2019).

Relationships with Criteria. ACT (2019) refers to relationships with criteria as the comparison between test item scores and criterion variables. Student readiness on the trajectories of college readiness and career readiness are the main interpretations of the ACT Aspire scores (ACT, 2019). Results may also be used to make predictions between ACT Aspire and ACT scores (ACT, 2019).

Consequences. Consequences, whether intended or unintended, are evaluated to determine the validity of the ACT Aspire (ACT, 2019). Variables such as behaviors and attitudes can also contribute to student achievement (ACT, 2019). A comprehensive list of unintended consequences is not available, nor can the consequences be expected (ACT, 2019).

Although validating ACT Aspire score interpretations continues to be a priority, academic achievement is the main interpretation to be validated (ACT, 2019). For this study, the third and fourth grade scores from the ACT Aspire Math Assessment will be reviewed based on the math curriculum used by the school to determine the effectiveness of the math curriculum.

Data Analysis

Table 7 outlines the analytic technique for each hypothesis in this study.

Table 7

Research Questions, Hypotheses, and Analyses

Research Question	Hypothesis	Variables	Statistical Test
RQ1: What effect, if any, does a math curriculum have on third and fourth grade ACT Aspire math scores in Arkansas?	H1: There will be no significant difference among third and fourth grade ACT Aspire math scores based on math curriculum.	IV-Math curriculum DV-Third and fourth grade ACT Aspire math scores	ANOVA
RQ2: How do demographic	H2: Math curriculum and	IV-Gender IV-Math curriculum	Two-Factor ANOVA

factors combined with curriculum effect ACT Aspire scores?	student gender will have a combined effect on third and fourth grade ACT Aspire math scores.	DV-Third and fourth grade ACT Aspire math scores	
	H3: Math curriculum and student grade level will have a combined effect ACT Aspire math scores.	IV-Grade level IV-Math curriculum DV-Third and fourth ACT Aspire math scores	Two-Factor ANOVA
	H4: Student grade Level and gender will have a combined effect on third and fourth grade ACT Aspire math scores.	IV-Grade level IV-Gender DV-Third and fourth grade ACT Aspire math scores	Two-Factor ANOVA

Summary

Chapter 3 provided an overview of the method that was used for this study, including the research questions and hypothesis, research design, participants and sampling. Chapter 3 also described the reliability and validity of the instrument utilized to collect data for this study as well as the data analysis plan.

CHAPTER 4: FINDINGS

The purpose of this quantitative, causal-comparative study was to explore the relationship between math curricula, ACT Aspire math scores, and student demographics among third and fourth grade students located in Guy-Fenter Educational Cooperative school districts. The researcher investigated the following research questions and hypotheses:

- RQ1: What effect, if any, does a math curriculum have on third and fourth grade ACT Aspire math scores in Arkansas?
    - H1: There will be no significant difference between third and fourth grade ACT Aspire math scores based on math curriculum.
- RQ2: How do demographic factors combined with curriculum affect third and fourth ACT Aspire math scores?
    - H2: Math curriculum and gender have a combined effect on third and fourth grade ACT Aspire math scores.
    - H3: Math curriculum and student grade level will have a combined effect on third and fourth grade ACT Aspire math scores.
    - H4: Student grade level and gender will have a combined effect on third and fourth grade ACT Aspire math scores.

This chapter is divided into three sections. The first section, Sample, describes the participants and demographic area in this study. The second section, Results, describes the two research questions as well as the analyses for the four hypotheses. The third section, Chapter Summary, summarizes the research questions and the results for this study.

Sample

The target population for this study included third and fourth grade students located in Guy-Fenter Educational Cooperative school districts (Table 8). All school districts located in the Guy-Fenter Cooperative area were asked through email to participate in the study. All 21 school districts responded giving permission to participate in the study. The researcher then surveyed the schools to determine the math curriculum used during the 2018-19 school year. Table 9 shows number of school districts and the number of students that utilized each math curriculum in the Guy-Fenter Educational Cooperative.

Table 8

Sample Demographic Information

	Gender		Total
Grade Level	Female	Male	
Third Grade	1689	1690	*n*=3379
Fourth Grade	1678	1699	*n*=3377
Total	*n*=3367	*n*=3389	*N*=6756

Table 9

Math Curricula used in school districts in the Guy-Fenter Educational Cooperative

Math Curriculum	Number of Districts	Number of Students
My Math	4	2845
Eureka Math	8	1147

Math Expressions	1	83
Go Math	3	355
Saxon	1	94
Investigations	4	2232
Total	21	*N*=6756

Results

The following section consists of an in-depth analysis for each of the two research questions. The first research question, with one associated hypothesis, explored the relationship between math curricula and ACT Aspire math scores. The second research question, with three associated hypotheses, explored the combined effects between math curricula, grade level, gender and ACT Aspire math scores.

Upon IRB approval, the researcher submitted a request with the ADE Data Center to receive the ACT Aspire Data. Third and fourth grade student ACT Aspire math data, including student gender and race, for 6,756 students within the 21 Guy-Fenter Educational Cooperative school districts was emailed to the researcher from ADE through a secure, password protected file. The data was analyzed based on the research questions and hypotheses as discussed in detail in the Results section of this chapter.

Research Question 1

The first research question was: *What effect, if any, does a math curriculum have on third and fourth grade ACT Aspire scores in Arkansas?* This research question focused only on the relationship between the math curricula and ACT Aspire math scores for third and fourth grade students. There was one hypothesis associated with this research question.

Using IBM Statistical Packages for the Social Sciences (SPSS), a one-way Analysis of Variance (ANOVA) was conducted for the hypothesis to determine if a significant relationship existed between the different levels of the independent variable (curriculum type) and the dependent variable (ACT Aspire math scores). A one-way ANOVA was the most appropriate statistical analysis to assess if mean differences existed between the dependent and a single independent variable. The null hypothesis was rejected when $p < 0.05$.

Hypothesis 1. *There will be no significant difference among third and fourth grade ACT Aspire scores based on math curriculum.* A one-way ANOVA was conducted to determine if a significant relationship existed between the independent variables (each of the six math curriculums) and the dependent variable (ACT Aspire math scores). The results of the ANOVA indicated a significant difference [F= (5, 6750)5.101, p=.000] in mean ACT Aspire math scores for students in different math curricula. To understand which curricula were associated with significantly different scores, a Tukey post hoc was conducted to compare the mean difference of the six math curricula. The post hoc test revealed a significant difference between math scores for students using My Math (M=413.89) compared to Go Math (M=415.00), as well as a significant difference between students using My Math (M=413.89) and Investigations (M=414.69). In other words, students using My Math curriculum had significantly lower scores when compared to those using Go Math or Investigations. According to the post hoc, there was no significant difference between any other comparison combinations. Table 10 displays the means and standard deviations for the six math curricula. Table 11 displays the Tukey post hoc comparison for math curriculum.

Table 10

Descriptive Statistics for Math Curricula based on 2019 Third and Fourth Grade ACT Aspire Math Scores

	n	*M*	*SD*
My Math	2845	413.89	4.279
Eureka Math	1147	414.48	4.372
Math Expressions	83	415.37	4.137
Go Math	355	415.00	4.184
Saxon	94	413.79	3.302
Investigations	2232	414.69	9.877

Note: *N*=6756; *p*=.081

Table 11

Tukey HSD Comparison for Math Curriculum

(I) Math Curriculum	(J) Math Curriculum	Mean Diff(I-J)	*SE*	*p*
My Math	Eureka	-.587	.233	.120
	Math Expressions	-1.480	.743	.347
	Go Math	-1.1033	.375	.039*
	Saxon	.107	.699	1.000
	Investigations	-.797	.189	.000*
Eureka	My Math	.587	.233	.120
	Math Expressions	-.893	.758	.847

	Go Math	-.517	.405	.798
	Saxon	.697	.716	.928
	Investigations	-.211	.242	.954
Math Expressions	My Math	1.480	.743	.347
	Eureka	.893	.758	.847
	Go Math	.376	.813	.997
	Saxon	1.586	1.005	.613
	Investigations	.682	.746	.943
Go Math	My Math	1.103	.375	.039*
	Eureka	.517	.405	.798
	Math Expressions	-.376	.813	.997
	Saxon	1.210	.774	.622
	Investigations	.306	.381	.967
Saxon	My Math	-.107	.699	1.000
	Eureka	-.693	.716	.928
	Math Expressions	-1.586	1.005	.613
	Go Math	-1.210	.774	.622
	Investigations	-.904	.702	.792
Investigations	My Math	.797	.189	.000*
	Eureka	.211	.242	.954
	Math Expressions	-.682	.746	.943
	Go Math	-.306	.381	.967
	Saxon	.904	.702	.792

* $p < 0.05$

Subsequent analyses. Since a significant difference was found between the six curriculum groups in the first analysis, a second analysis was performed to further explore mean ACT Aspire math score differences by curriculum type. Because the group sizes were unequal, the researcher combined Saxon, Go Math, and Math Expressions (the three smallest curriculum groups) in to one group (called ‘Other’, see Table 11). My Math, Investigations, and Eureka remained as individual groups.

The results of the one-way ANOVA again suggested that there were significant differences between the math curricula [F (3, 6752) =7.477, p=.000)]. A Tukey post hoc was conducted to determine the mean difference of the regrouped math curricula. The post hoc revealed that students using My Math (M=413.89) had significantly lower scores than students using Investigations (M=414.69). The post hoc also revealed that students using My Math (M=413.89) had significantly lower scores than students using a curriculum in the combined group labeled ‘Other’ (M=414.84). According to the post hoc, there was no significant difference between any other comparison combinations. Table 12 shows the means and standard deviations for the regrouped math curricula. Table 13 displays the Tukey post hoc comparison for math curriculum regrouped to combine Saxon, Go Math and Math Expressions in to one group called ‘Other’.

Table 12

Descriptive Statistics for the Regrouped Math Curricula based on 2019 Third and Fourth Grade ACT Aspire Math Scores

	N	*M*	*SD*
My Math	2845	413.89	4.279

Eureka Math	1147	414.48	4.372
Investigations	2232	414.69	9.877
Other	532	414.84	4.060

Note: *N*=6756; *p*=.081

Table 13

Tukey HSD Comparison for Math Curriculum Regrouped

(I) Math Curriculum	(J) Math Curriculum	Mean Diff(I-J)	*SE*	*p*
My Math	Eureka	-.587	.233	.120
	Other	-.948	.315	.014*
	Investigations	-.797	.189	.000*
Eureka	My Math	.587	.233	.120
	Other	-.362	.350	.730
	Investigations	-.211	.242	.954
Other	My Math	.948	.315	.014*
	Eureka	.362	.350	.730
	Investigations	.151	.322	.966
Investigations	My Math	.797	.189	.000*
	Eureka	.211	.242	.954
	Other	-.151	.322	.966

* $p < 0.05$

Research question one summary. Based on the results obtained from the one-way ANOVA, a significant difference was indicated in the mean ACT Aspire math scores for students utilizing different math curricula. Students using My Math

(*M*=413.89) curriculum had significantly lower scores when compared to those using Go Math (*M*=415.00) or Investigations (*M*=414.69).

Research Question 2

The second research question in this study was: *How do demographic factors combined with curriculum effect ACT Aspire scores?* The purpose of this research question was to determine whether a combination of the math curriculum and/or demographic factors (gender and grade level) influenced the third and fourth grade ACT Aspire math scores. There were three hypotheses associated with this research question. Using IBM Statistical Packages for the Social Sciences (SPSS), a two-factor Analysis of Variance (ANOVA) was conducted for each of the three hypotheses. A two-factor ANOVA can test the combined (i.e., interaction) effect of two independent variables (i.e., factors) on a dependent variable. Each hypothesis tested under research question two included two factors—hypotheses 2 and 3 included type of math curriculum and a demographic factor (student gender or student grade) as the independent variables, and hypothesis four included grade level and gender as the independent variables. All hypotheses tested for this research question included the same dependent variable (ACT Aspire math scores). The null hypothesis was rejected when $p < 0.05$. The statistical findings are as follows:

Hypothesis 2. *Math curriculum and gender have a combined effect on the third and fourth grade ACT Aspire math scores.* A two-way between-subjects ANOVA was conducted to explore the possible interaction effect of math curriculum and gender on third and fourth grade ACT Aspire math scores. The analysis indicated that the interaction of these two variables on the dependent variable was not significant [*F* (5,

6744) =1.185, *p*=.314]; therefore, the hypothesis was rejected. Since there was no interaction effect, the main effects were explored. The main effect of gender was not significant [*F* (1, 6744) =.023, *p*=.881]. However, the main effect of math curriculum was significant [*F* (5, 6744) =5.064, *p*=.000]. This underscores the findings from research question one/hypothesis one, which also determined that there was a significant difference between the math curricula and the third and fourth grade ACT Aspire math scores. A post hoc was not conducted for the main effect of math curriculum in this analysis, as it was already completed in the analysis for the same variable in hypothesis 1. Table 14 displays the ANOVA results for gender and math curriculum based on ACT Aspire math scores. Table 15 shows the means for the combination of gender and math curriculum.

Table 14

Analysis of Variance for Gender and Math Curriculum based on the Third and Fourth Grade ACT Aspire Math Scores

	df	*MS*	*F*	*p*
Gender	1	1.004	.023	.881
Math Curriculum	5	225.248	5.064	.000
Gender X Math Curriculum	5	52.702	1.185	.314

Table 15

Means for Gender x Math Curriculum

	Gender	
Math Curriculum	Female	Male
My Math	413.97	413.82

Eureka Math	414.46	414.50
Math Expressions	415.08	415.65
Go Math	415.27	414.74
Saxon	413.93	413.65
Investigations	414.35	415.02

Hypothesis 3. *Math curriculum and student grade level have a combined effect on third and fourth grade ACT Aspire math scores.* A two-way between-subjects ANOVA was conducted to explore the possible interaction effect of math curriculum and student grade level on third and fourth grade ACT Aspire math scores. The analysis indicated that the interaction of these two variables on the dependent variable was not significant [F (5, 6744) =1.487, p=.190)]; therefore, the hypothesis was rejected. Since there was no interaction effect, the main effects were explored. The main effect of student grade level was significant [F (1, 6744) =34.708, p=.000)], with mean scores for fourth grade (M=416.16) being over three points higher than third grade (M=412.99). Further, the main effect of math curriculum was significant as well [F (5, 6744) =4.744, p=.000)]. This further underscores the findings from research question one/hypothesis one, which also determined that there was a significant difference between the math curricula and the third and fourth grade ACT Aspire math scores. A post hoc was not conducted for the main effect of grade level since there were only two levels of the variable (thus making between-group comparison possible); a post hoc was not conducted for math curriculum in this analysis either, as it was already completed in the analysis for the same variable in hypothesis one. Table 16 displays the Analysis of Variance for math curriculum and

student grade level. Table 17 displays the means for each grade level and each of the six math curricula.

Table 16

Analysis of Variance for Math Curriculum and Student Grade Level

	df	*MS*	*F*	*p*
Student Grade Level	1	1481.709	34.708	.000
Math Curriculum	5	202.531	4.744	.000
Student Grade Level X Math Curriculum	5	63.487	1.487	.190

Table 17

Means for Grade Levels x Math Curriculum

	Grade Level	
Math Curriculum	Third Grade	Fourth Grade
My Math	412.51	415.34
Eureka Math	413.30	415.56
Math Expressions	413.97	416.61
Go Math	414.13	415.75
Saxon	413.58	414.05
Investigations	413.23	416.16

Hypothesis 4. *Student grade level and gender will have a combined effect on third and fourth grade ACT Aspire math scores.* A two-way, between-subjects ANOVA was conducted to explore the possible interaction effect between student grade level and gender based on third and fourth grade ACT Aspire math scores. The analysis indicated

that the interaction of these two variables on the independent variable was not significant [*F* (1, 6752) =.004, *p*=.950]; therefore, the hypothesis is rejected. Since there was no interaction effect, the main effects were explored. The main effect of gender was not significant [*F* (1, 6752) =.829, p=.363]. However, the main effect of student grade level was significant [*F* (1, 6752) =282.502, p=.000], with mean scores for fourth grade (*M*=416.16) being over three points higher than third grade (*M*=412.99). A post hoc was not conducted because there were only two levels of gender, thus making between-group comparison possible. Table 18 displays the Analysis of Variance for student grade level and gender based on the ACT Aspire math scores. Table 19 shows the means for each grade level and each gender.

Table 18

Analysis of Variance for Student Grade Level and Gender Based on Third and Fourth Grade ACT Aspire Math Scores

	df	*MS*	*F*	*p*
Student Grade Level	1	12184.664	284.502	.000
Gender	1	35.517	.829	.363
Student Grade Level X Gender	1	.171	.004	.950

Table 19

Means for Grade Level and Gender

	Gender	
Grade Level	Female	Male
Third Grade	412.92	413.06
Fourth Grade	415.60	415.75

Research question two summary. Based on the results obtained from the two-way, between-subjects ANOVA, a significant difference was not indicated for the combined effect of math curriculum and gender, math curriculum and student grade level, or student grade level and gender in the mean ACT Aspire math scores for students utilizing different math curricula. However, the main effect of student grade level was significant [F (1, 6744) =34.708, p=.000)], with mean scores for fourth grade (M=416.16) being over three points higher than third grade (M=412.99). Further, the main effect of math curriculum was significant as well [F (5, 6744) =4.744, p=.000)].

Chapter Summary

This chapter presented the detailed results of this quantitative study. The data for two research questions was presented and analyzed through four hypotheses. The results for the first research question determined that there was a significant difference between the math curricula based on the third and fourth grade ACT Aspire math scores. The scores for My Math were significantly lower than Go Math as well as Investigations. However, there was no significant difference between any of the other curriculums. When the researcher regrouped the math curriculum to combine Go Math, Math Expressions and Saxon into a group labeled 'Other', My Math was still significantly lower than Investigations as well as the combined group referred to as "Other". Again, there was no significant difference between any of the other curriculum groups.

The second research question was broken down into three hypotheses, each of which tested the combined effect of two independent variables on the same dependent variable (ACT Aspire math scores). The second hypothesis analyzed the combined effect of the math curriculum and gender on ACT Aspire math scores. The results indicated there was no combined effect of math curriculum and gender on third and fourth graders' ACT Aspire math scores; therefore, the hypothesis was rejected. The main effects, gender and math curriculum, were analyzed. No significant difference was found by gender; however, a significant difference was found according to math curriculum. Again, students using My Math curriculum had significantly lower scores compared to those using Go Math or Investigations based on third and fourth ACT Aspire math scores.

The third hypothesis analyzed the combined effect of math curriculum and student grade level on ACT Aspire math scores. The results indicated there was no combined effect of math curriculum and student grade level on third and fourth grade ACT Aspire math scores; therefore, the hypothesis was rejected. The main effects, student grade level and math curriculum, were analyzed. A significant difference was found by both main effects, student grade level and math curriculum. The main effect, student grade level, showed that fourth grade scores were significantly higher than third grade scores. Again, students using My Math curriculum had significantly lower scores compared to those using Go Math or Investigations based on third and fourth ACT Aspire math scores.

The fourth hypothesis analyzed the combined effect of student grade level and gender on ACT Aspire math scores. The results indicated there was no combined effect on student grade level and gender on third and fourth grade ACT Aspire math scores; therefore, the hypothesis was rejected. The main effects, student grade level and gender, were analyzed. A significant difference was found by student grade level, with fourth grade scores being higher than third grade scores; however, no significant difference was found by gender.

CHAPTER 5: DISCUSSION

All public school districts in the state of Arkansas are mandated to utilize the Arkansas State Standards to guide instruction; however, schools are not required to adopt a specific curriculum. Currently, little to no research has been completed to determine if a specific curriculum has an effect on ACT Aspire math scores in grades three and four. Thus, the purpose of this quantitative, causal-comparative study was to explore the relationship between math curriculums, ACT Aspire Scores, and student demographics in Arkansas among third and fourth grade students located in Guy-Fenter Educational Cooperative school districts. The following research questions and hypotheses guided this study:

- RQ1: What effect, if any, does a math curriculum have on third and fourth grade ACT Aspire math scores in Arkansas?
    - H1: There will be no significant difference between third and fourth grade ACT Aspire math scores based on math curriculum.
- RQ2: How do demographic factors combined with curriculum affect third and fourth ACT Aspire math scores?
    - H2: Math curriculum and gender have a combined effect on third and fourth grade ACT Aspire math scores.
    - H3: Math curriculum and student grade level will have a combined effect on third and fourth grade ACT Aspire math scores.
    - H4: Student grade level and gender will have a combined effect on third and fourth grade ACT Aspire math scores.

This chapter is divided into four sections. The first section is a summary of findings for this study. The second section outlines the conclusions drawn from the research questions as well as the hypotheses based on the findings presented in the previous chapter. Finally, the third section outlines the implications for practice and suggestions for future research. This chapter ends with a chapter summary.

Summary of Findings

The results for the first research question determined that there was a significant difference between the math curricula based on the third and fourth grade ACT Aspire math scores. The scores for My Math were significantly lower than Go Math as well as Investigations. However, there was no significant difference between any of the other curriculums. This was also evident when the researcher regrouped the math curriculum to combine Go Math, Math Expressions and Saxon into a group labeled 'Other'.

There were three hypotheses associated with the second research question in this study. The second hypothesis analyzed the combined effect of the math curriculum and gender on ACT Aspire math scores. The results indicated there was no combined effect of math curriculum and gender on third and fourth graders' ACT Aspire math scores. The main effects, gender and math curriculum, were also analyzed. No significant difference was found by gender; however, a significant difference was found according to math curriculum. The third hypothesis analyzed the combined effect of math curriculum and student grade level on ACT Aspire math scores. The results indicated there was no combined effect of math curriculum and student grade level on third and fourth grade ACT Aspire math scores. The main effects, student grade level and math curriculum, were also analyzed. A significant difference was found by both main effects, student grade level and math curriculum. The fourth hypothesis analyzed the combined effect of student grade level and gender on ACT Aspire math scores. The results indicated there was no combined effect on student grade level and gender on third and fourth grade ACT Aspire math scores. The main effects, student grade level and gender, were also analyzed. A significant difference was found by student grade level; however, no significant difference was found by gender.

Discussion

Although several interpretations can be drawn from the findings discussed in the previous section, the researcher focused on the following three interpretations in this section: (a) Type of math curriculum does affect math scores, (b) There was a significant difference in math scores by grade level, and (c) Math scores based on gender were not significantly different in this study.

Type of Curriculum Does Affect Math Scores

Steiner (2017) found that curriculum is a critical factor in student success and can substantially impact student learning. The hypothesis for the first research question stated that there will be no significant difference among third and fourth grade ACT Aspire math scores based on math curriculum. However, this study has provided clear evidence that there was a significant difference in math curriculum based on third and fourth grade ACT Aspire math scores. According to this study, the math curriculum, My Math, scored significantly lower than the math curricula Go Math and Investigations. Although My Math scored significantly lower than Go Math as well as Investigations, the mean scores only differed by less than two points. When the math curricula were regrouped, My Math still scored significantly lower; however, the mean scores only differed by less one point. This finding was reiterated in hypothesis one, two, and three.

My Math. My Math, published by McGraw-Hill, is a K-5 curriculum (McGraw-Hill, n.d.); it was one of the six curriculums taught in the 21 districts that participated in this study. My Math was written after the release of CCSS and follows the scope set by CCSS (McGraw-Hill, n.d.). McGraw-Hill (n.d.) states that all three aspects: (a) focus, (b) coherence, and (c) rigor are balanced in the curricular program to promote student learning. *Consumer Reports* completed a survey on math curricula and found that My Math scored lower than other math curricula used by districts in the Guy-Fenter Educational Cooperative. My Math did not meet criteria for kindergarten, partially met criteria for first and second grade, and met criteria for fourth and fifth grade (Heitin, 2015).

In this study, the group sizes were unequal among the six curriculum groups. The My Math curriculum group was the largest group in this study with 2,845 students receiving math instruction from the My Math curriculum. Investigations consisted of 2,232 students followed by Eureka which consisted of 1,147 students. The smallest group, Math Expressions, consisted of 83 students. Group size may have attributed to the findings in this study. The amount of time a school district used the curriculum may have also attributed to the findings in this study. The researcher did not determine the number of years the curriculum was used for instruction for this study. According to Steiner (2017), most research studies on curriculum are completed within a year; however, a curriculum needs to be used consistently over several years to determine the curriculum's impact on student learning.

There was a Significant Difference in Math Scores by Student Grade Level

The third and fourth hypotheses determined that there was a significant difference in students' ACT Aspire math scores according to student grade level. The difference between third grade mean scores (M=412.99) and fourth grade mean scores (M=415.68) was almost three points. Although a significant difference between the mean scores was indicated, the ACT Aspire math high score as well as the ACT Aspire readiness benchmark score is higher for fourth grade. As displayed in Table 4, the third grade high score is six points less than the fourth grade high score, and there is a three point difference in the grade level benchmark. This progression trend continues throughout tenth grade, the last year to take the ACT Aspire (ACT, 2019). Since ACT Aspire begins in third grade, it is possible that the significant difference in scores according to grade level may actually be because, for fourth graders, it was the second time they took the test--this is similar to pre-test treatment interaction, a common threat to external validity (ACT, 2019).

Math Scores Based on Gender were not Significantly Different

In a 2007 study completed by Cornell University, Azar (2010) found that that the ratio for who scored in the top 10,000 in mathematics was one female to two to four males. However, in this study, the second and fourth hypotheses determined that there was not a significant difference in math scores according to gender. The mean scores for males (M=414.41) were almost one- half point more than females (M=414.25), a difference that is not statistically significant. It is possible that the lack of gender differences in math scores is because the children in this study were young (third and fourth graders). Ganley (2018) stated that younger students--those under the age of nine--

performed at the same level despite their gender. The students in this study fit that age range. Further, Cimpian (2018) found that there was no gender gap in kindergarten, but a standard deviation of .25 in favor of males is found by third grade. Students in third and fourth grade were typically between 8-10 years old. Based on this research, the gender gap in this study would just be in the beginning stages and may not have been noticeable yet.

Implications

For this study, the researcher narrowed the focus to two areas for implications. The first area, Implications for Practice, discusses how the results of this study may impact current educational practices. The second implication, Implications for Future Research, discusses how other researchers could continue and build upon this study.

Implications for Practice

This section focuses on two main educational groups that could be affected by the results of this study. The first group is Arkansas Department of Education (ADE), which oversees current mandates and effective instructional practices, including standards and curriculum. The second group is k-12 teachers and administrators. K-12 teachers and administrators are responsible for implementing current standards through effective instructional practices, including curriculum.

Arkansas Department of Education. The ACT Aspire is Arkansas's mandated standardized assessment; however, Arkansas State Standards do not completely correlate with ACT Aspire. Although school districts do not have to adopt a curriculum, ADE does provide school districts with curriculum recommendations based on alignment with standards. ADE could utilize the findings from this study when making recommendations on curriculum based on which curriculum aligns with both Arkansas State Standards and ACT Aspire.

K-12 teachers and administrators. School districts are responsible for providing instructional materials and resources, including curriculum, to teachers based on Arkansas State Standards and instructional needs. The findings of this study could be informative to teachers and administrators to help determine which curriculum best meets the instructional needs of their students. The findings could also be beneficial by giving teachers a baseline of scores to compare future scores to as they continue to teach the same curriculum. Guy-Fenter Educational Cooperative may also find this study helpful as it provides them with a comparison from schools in their cooperative area.

Implications for Future Research

This research study found that math curriculum does affect ACT Aspire math scores in third and fourth grade. However, questions outside of this scope have yet to be answered. The researcher recommends that further research is completed in the following areas:

1. A replicate study focusing on school districts across the state with similar student demographics, including student population and socio-economic status.
2. A replicate study to compare fourth grade and eighth grade focusing on gender gaps.
3. An expanded study to include more school districts, more grade levels and more math curriculum choices.

4. A 3-5 year longitudinal study to determine the effectiveness of utilizing the same math curriculum over a longer period of time.

Chapter Summary

This study determined that third and fourth grade student math scores on the ACT Aspire were affected by the math curriculum utilized during instruction. The math curriculum, My Math, scored significantly lower than Go Math as well as Investigations. Based on this study, there was also a significant difference between the third grade and fourth grade ACT Aspire math scores. Although research stated that math scores may be affected by gender, this study found there was no significant difference on ACT Aspire math scores based on gender. Implications for this study included implications for practice and implications for further research. ADE, school district administrators and K-12 teachers can use the results from this study to determine the most effective curriculum which is aligned with Arkansas State Standards as well as ACT Aspire. The implications for future research recommends four different areas that could be researched including two replicate studies, an expanded study and a longitudinal study.

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APPENDIX

ARKANSAS TECH UNIVERSITY

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December 2, 2019

To Whom It May Concern:

The Arkansas Tech University Institutional Review Board Chair has deemed the IRB application for Rebecca Reed Cook's proposed research, entitled "Adding It Up: The Effects of Math Curriculum on Third and Fourth Grade ACT Aspire Math Scores in Arkansas" to be exempt under Section 104, Category 2, subpart i. Research activities in which the only involvement of human subjects will be in one of more of the exempt categories defined by the federal regulations are given an exempt determination rather than IRB approval. Thus, no IRB approval number has been assigned to this study. The Chair approves for the researcher(s) to proceed with the study.

Please note that, in the event that any of the parameters of the study change, the researcher may be required to submit an amended IRB application.

Sincerely,

Gabriel L. Adkins, Ph.D.
Institutional Review Board Chair
Arkansas Tech University