THE IMPACT OF DEPARTMENTALIZED AND TRADITIONAL INSTRUCTIONAL SETTINGS ON ECONOMICALLY DISADVANTAGED FOURTH GRADE STUDENTS' MATHEMATICAL PROFICIENCY

by

Elizabeth Courtney Medlock

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

All students must have opportunities to achieve high levels of mathematics learning, thus, organizational settings in the field of education should be carefully examined to determine the extent to which the instructional environment affects student achievement, growth, and application of grade level standards for students identified as economically disadvantaged. The purpose of this quantitative, causal-comparative study was to investigate differences in mathematical proficiency of economically disadvantaged fourth-grade students in departmentalized versus traditional instructional settings as measured by the 2019 Maryland PARCC mathematics assessment. A cluster sample of low-income fourth-grade students from 80 public elementary schools in a large, suburban school district in central Maryland was used to examine statistical differences in mathematical proficiency of the two settings across three dependent variables: (a) modeling, (b) reasoning, and (c) overall achievement. Archival data were collected from the instructional data division of the school district under study. An independent samples *t*-test was used to examine differences in group overall proficiency means based on instructional setting. Two Mann-Whitney U analyses were conducted to determine if differences in group modeling and reasoning medians existed based on setting. Results indicated economically disadvantaged students' overall proficiency scores were statistically significantly higher in a departmentalized setting than in a traditional setting. There were no differences in reasoning and modeling scores based on setting. Implications for instructional practice and suggestions for future research are discussed.

Keywords: Instructional settings, departmentalized, traditional, mathematics proficiency, mathematics achievement, economically disadvantaged, low-income students

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Dedication

This work of this dissertation is dedicated to my three daughters, Layla, Liliana, and Logan. May your life outcomes never be predicted by your challenging circumstances. Be an outlier.

Acknowledgments

I would like to first and foremost thank my Heavenly Father, for blessing me not only with this incredible opportunity to pursue higher education, but also with the grit and persistence to complete this dissertation with many odds stacked against me. I am nothing without Him and my accomplishments pale in comparison to His grace, mercy, and love.

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I am extremely grateful for the support of my husband Luke and my girls, Layla, Liliana, and Logan. Luke, thank you for holding down the fort many weekends so I could settle in at the library or lock myself in our office and plug away at this degree. You've never complained and have been my biggest cheerleader. This degree is just as much yours as it is mine and I appreciate you more than you'll ever know. To my girls, you may never know the sacrifices you have made for this to be completed until you are older. I hope my example of hard work and determination motivates and inspires you to tackle any challenge that comes your way and to never give up. Always remember to "Be strong in the Lord and in His mighty power" Ephesians 6:10.

Finally, to my many friends and family who have prayed for and encouraged me over and over – your love and friendship are not taken for granted and I'm so grateful you've been positioned in my life. Your positive influence in my life shows that anything is possible when you have the best people supporting you.

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List of Abbreviations

American College Testing (ACT)

Common Core State Standards Initiative (CCSSI)

Conceptual Representational Abstract (CRA)

Elementary and Secondary Education Act (ESEA)

Every Student Succeeds Act (ESSA)

Free and Reduced Meals (FARMS)

Institutional Review Board (IRB)

Multivariate Analysis of Variance (MANOVA)

Maryland State Department of Education (MSDE)

National Assessment of Educational Progress (NAEP)

No Child Left Behind (NCLB)

National Council of Teachers of Mathematics (NCTM)

National Governors Association (NGA)

National Research Council (NRC)

Organization for Economic Cooperation and Development (OECD)

Partnership for Assessment of Readiness for College and Careers (PARCC)

Programme for International Student Assessment (PISA)

Smarter Balanced Assessment Consortium (SBAC)

Smarter Balanced Assessment System (SBAS)

Standards for Mathematical Practice (SMP)

United States Department of Education (USDOE)

Zone of Proximal Development (ZPD)

CHAPTER ONE: INTRODUCTION

Overview

Chapter 1 provides background information about classroom instructional settings and the evolution of departmentalized and traditional models, history of education and educational laws, social and theoretical contexts for instructional settings, and an overview of the most recent research for and against departmentalized structures. After the background, a statement of the problem and purpose of the study are discussed to support the rationale for the study. Finally, the significance of the study, research question, and definitions are outlined.

Background

Success in the 21st-century society and workplace requires many skills associated with deeper learning; namely, critical thinking, problem-solving, and communication (Lai & Viering, 2012; U.S. Department of Education Office of Educational Technology, 2013). In mathematics, supporting students' more in-depth learning of the concepts involves fostering analytical reasoning and complex problem-solving skills. Responsively, leaders of mathematics education have pushed for significant shifts in mathematics instruction in K-12 classrooms (National Education Association, 2012; National Mathematics Advisory Panel, 2008; NCTM, 2000; NCTM, 2014). In response to this call, the Common Core State Standards, aligned with the National Research Council's (Kilpatrick et al., 2001) Five Strands of Proficiency, were developed as a framework for more rigorous mathematics instruction to best prepare all students for college and career readiness and supporting the application of knowledge through higher order thinking skills (CCSSI, 2010). The core standards initiative requires a comprehensive understanding of mathematics, an understanding many elementary educators lack due to methods learned in their early academic experiences. This gap in understanding presses many educators to relearn mathematics conceptually and gain specialized knowledge of how mathematics is connected and coherent across grade levels. These requirements have posed quite a challenge for many elementary teachers, considering many dislike mathematics, suffer from math anxiety, and sorely lack the understanding needed to fulfill the requirements of the newly adopted standards (Beilock & Maloney, 2015; Gellert, 2000; Gresham, 2018; Swars & Chestnutt, 2016). Moreover, teachers have reported difficulties developing expertise in multiple subject areas while meeting the demands of state and federal mandated accountability measures and supporting the diverse and increasingly more challenging behavioral needs of students (Scholastic, 2014; Swars & Chestnutt, 2016). Teachers continue to report a need for more quality professional development and additional planning time to ensure successful implementation of the Common Core standards (Scholastic, 2014; Swars & Chestnutt, 2016).

Despite the call to action since Common Core's inception in 2010, American student performance on the most recent international and national mathematics assessments has continued to decline or hold steady with little evidence of growth (Desilver, 2017; Gewertz, 2019; Hansen, Levesque, Valant, & Quintero, 2018; Mullis, Martin, Foy, & Hooper, 2016; OECD, 2016). As a result, Americans remain ranked below their international counterparts in mathematics and science, not meeting the high expectations outlined in the standards (Mullis, Martin, Foy, & Hooper, 2016; OECD, 2016). Additionally, persistent racial, ethnic, and income achievement gaps have pressed educators to investigate and ensure all students have access to high levels of mathematics learning (NCTM, 2014). In response to the country's international, national, and state underperformance on mathematics assessments and the pressing achievement gaps, school and district level leadership have explored many avenues to make an impact on student outcomes, including different combinations of instructional settings. These efforts have been focused on bridging the gap between instructor capacity and comfort level to best leverage their human resources for the most significant impact on student achievement (Gewertz, 2019).

Departmentalization models originate to eighteenth-century organizational settings that divided the school into reading and writing departments (Bunker, 1916). Both departments were set up in separate rooms with teachers and assistants assigned to each room. Although it was a common way to divide instruction, the primary structure in early American education was the one-room schoolhouse (Otto & Sanders, 1964). Much like traditional K-5 instructional settings in the present day, students in the one-room schoolhouse were grouped by grade level and one teacher taught all subjects to one group of students. The evolution of departmentalization began in the early 19th century as schools separated math and reading instruction into separate departments (Bunker, 1916). Later, the platooning concept became popular in the 1930s when students were divided into two groups of platoons with one group attending academic classes while the other group participated in the arts and switching focus after a specified amount of time (Otto & Sanders, 1964).

Changes in U.S. education law have placed increased pressure on educational leadership to make changes to structures and systems to best align with top-down initiatives by the federal government. In 2001, President Bush signed the No Child Left Behind Act (NCLB) to highlight inequalities between subgroups and provide parameters for addressing the achievement gap between economically underprivileged students and their economically privileged counterparts. Successfully closing the achievement gap meant displaying steady gains on standardized assessments in both mathematics and reading and increasing proficiency of all students on both measures. In 2011, the Obama administration created a more flexible initiative aligned with the Elementary and Secondary Education Act (ESEA) of 1965. This new initiative, the Every

Student Succeeds Act (ESSA), gave states more freedom to opt out of specific NCLB mandates and establish goals to support progress and achievement for all students and close learning opportunity gaps for those students who struggle, especially special subgroups such as students with limited English proficiency, students with disabilities, and students who come from low-income families. Additionally, states are required to adopt college and career ready standards and craft a valid and reliable statewide assessment measure that ensures growth and achievement is attainable.

The achievement gap is often discussed considering the opportunity gap, or the relationship between a students' socioeconomic status and their achievement. However, despite the efforts of major educational policies, the opportunity gap has remained unchanged (Hanushek, Peterson, Tapley, & Woessman, 2019). The failure of such policies to narrow the opportunity and achievement gaps suggests the need to reconsider what approaches school and district leadership take to mitigate disparities (Hanushek et al., 2019). The persistent gaps combined with top down mandates and continued student underperformance in mathematics have placed increased pressure on educators and leadership to find innovative and economical strategies to leverage the most impact. Organizational settings in elementary schools is one area that leadership examines. Elementary schools typically utilized a traditional format, with many schools using some form of departmentalization in grades 4-5 (Jacob & Rockoff, 2011; Strohl, Schmertzing, Schmertzing, & Hsiao, 2014). Departmentalized classrooms vary in format but typically involve one educator responsible for providing instruction in one or two subject areas to all students within a grade level (Chan & Jarman, 2004; Chang, Munoz, & Koshewa, 2008; Gerretson, Bosnick, & Schofield, 2008; Nelson, 2014; Reys & Fennel, 2003; Yearwood, 2011). Traditional, self-contained classrooms require the educator to be a generalist and provide instruction in all core subject areas to one group of students (Chan & Jarman, 2004; Chang et al., 2008; Hood, 2009; Nelson, 2014; Yearwood, 2011).

Research has indicated that departmentalized formats provide the educator with a reduced workload, higher morale, and more time to plan quality lessons, deeply understand content and standards and meet the needs of every student (Brobst, Markworth, Tasker, & Ohana, 2017; Chan & Jarman, 2004; Fennel, 2011; Gerretson et al., 2008; Reys & Fennel, 2003; Strohl, et al., 2014; Timms, Graham, & Cottrell, 2007). Proponents of traditional classrooms, however, contest that departmentalized formats do not support strong student-teacher relationships and social-emotional development is best fostered in a classroom with one teacher (Baroody, 2017; Chang et al., 2008; Heathers, 1969; McGrath & Rust, 2002; McPartland, 1987, 1990; Roorda, Koomen, Spilt, & Oort, 2011).

Constructivist views of learning provide the theoretical foundation for mathematics education and connect the instructional setting and the role of the educator to students' acquisition of mathematical knowledge (Miller, 2001). Piaget (1952), known as the father of constructivism, reasoned the development of knowledge is active and adaptive through assimilation and accommodation of information. The educator guides students through the discovery of mathematical ideas and facilitates reasoning and discourse. Further, he believed mathematics must be taught concretely rather than through rote procedures or facts. Vygotsky (1934/1962) combined Piaget's constructivist principles with other social elements, emphasizing the importance of collaboration, social interaction, communication, environment, and personal thinking processes to the conceptualization of mathematics (Powell & Kalina, 2009; Webel, 2013). In these learning environments, the educator is responsible for planning and facilitating learning experiences that involve cooperative structures, ensuring social interactions are positively contributing to a vibrant learning community and providing frequent opportunities for students to reason about and reflect upon the mathematics. The teacher's role, thus, is central to learning and their knowledge of mathematical theory and connections among standards is critical to the development of student knowledge.

Problem Statement

For students to learn mathematics at the level of rigor outlined in the Common Core standards, mathematics instruction must be aligned accordingly (Webel, Conner, Sheffel, Tarr, & Austin, 2017). Algebra is a language, taught at different levels from kindergarten to college. Mathematics skills build upon each other year after year, thus skills not mastered in one year make it challenging for new skills to be mastered in succeeding years (Uzzi, 2018). Elementary teachers must have the specialized knowledge to teach mathematics and a strong understanding of standards coherence across grade levels to best support the progressive development of mathematics over the years. However, despite the National Council of Teacher's recommendation that elementary teachers take coursework in all four domains of mathematics (algebra, number and operations, geometry, and probably/statistics), only 10% of elementary teachers have completed coursework in all four and the majority of elementary teachers have only taken one or two courses (Banilower et al, 2013). Thus, many beginning and experienced U.S. elementary teachers struggle to evoke conceptual understanding of fractions, division, and place value (Ma, 2010). This need is critical, as students' knowledge of fractions and whole number division predicts mathematics achievement in high school (Siegler et al., 2012).

Additionally, many students coming from low-income families do not perform on grade level and often enter their mathematics courses with significant gaps in their understanding (Public Impact, 2018). Between 4th and 8th grade, high poverty students begin to rapidly fall behind their more affluent peers and reach lower levels of achievement (Beaton et. al, 1996). The persistent, large achievement gap between low-income students and their more affluent peers is a national concern, one that could potentially be addressed by organizational reforms that support teacher expertise and successful instructional experiences (Balfanz & Byrnes, 2002).

Because it is unrealistic for elementary teachers to be experts in all content areas they teach, different models of organizing school instruction that support content area specialization are necessary (Reys & Fennel, 2003). However, proponents of traditional classrooms contest that the social emotional benefits of being with the same educator for most of the day outweigh the academic benefits of a specialized structure (Anderson, 1962; Baroody, 2017; Chang et al., 2008; Heathers, 1969; McGrath & Rust, 2002; McPartland, 1987, 1990; Roorda et al., 2011). The research regarding academic achievement differences per setting has been limited and inconclusive; some studies have shown significant differences in student outcomes per instructional setting (Gerberich & Prall, 1931; Gibb & Matala, 1962; Gould, 1973; Moore, 2008; Nelson, 2014; Ponder, 2008; Taylor-Buckner, 2014; Williams, 2009; Yearwood, 2011). However, other studies show no difference in achievement per setting (Bastain & Fortner, 2018; Chennis, 2018; Dymond, 2017; Garcia, 2007; Jack, 2014; Kent 2010; Koch, 2013; Lambert, 2008; Lee, Martin, & Trim, 2016; McGrath & Rust, 2002; Mitchell, 2013; Price, Prescott, & Hopkins, 1967; Ray, 2017). Empirically, the evidence for departmentalization remains unclear.

Purpose Statement

The purpose of this study was to explore differences in mathematical proficiency of economically disadvantaged fourth-grade students who received instruction in departmentalized instructional settings versus economically disadvantaged students who received instruction in traditional settings. Educators of mathematics at all grade levels must be skilled in the underpinnings of the concepts they teach and know the most effective ways to develop students' modeling, reasoning, and procedural fluency (Reys & Fennel, 2003). Presenting curriculum narrowly, especially in the early years, misrepresents the power of mathematics to students in such a way that it potentially negatively affects student's attitudes and beliefs (Reys & Fennel, 2003). Moreover, the foundation for success in algebra and more challenging mathematics courses is laid in elementary school (Knuth, Stephens, Blanton, & Gardiner, 2016). Further, the opportunity gap, or the relationship between a student's socioeconomic status and their achievement has persisted for the past 50 years (Hanushek, Peterson, Talpey, & Woessman, 2019). School systems play a key role in the efforts to reduce the gaps; thus, it is important to examine which factors may support or hinder the success of students with limited financial resources (Scherer, 2013). The limited and unclear evidence in the literature over the past 90 years and the need for all students to have access to high-quality mathematics instruction formed the rationale for this investigation.

Significance of the Study

Studies conducted on instructional settings have examined the impact on overall achievement by setting in various content areas. Of the 24 studies retrieved over the course of 90 years, 18 have investigated mathematics achievement (Batain & Fortner, 2018; Becker, 1987; Dymond, 2017; Gerberich & Prall, 1931; Gibb & Matala, 1962; Jack, 2014; Kent, 2010; Lee et al., 2016; Mitchell, 2013; Moore, 2008; Nelson, 2014; Patton, 2003; Ponder, 2008; Price et al., 1967; Ray, 2017; Taylor-Buckner, 2014; Williams, 2009; Yearwood, 2011). See Table 1 for a list of those studies. Studies that examine modeling and reasoning proficiency by setting or that have been conducted in the state of Maryland have not been found. As previously mentioned, the literature on instructional settings is inadequate, inconclusive, and inconsistent (Bastain &

Fortner, 2018; Chennis, 2018; Dymond, 2017; Garcia, 2007; Gerberich & Prall, 1931; Gibb & Matala, 1962; Gould, 1973; Jack, 2014; Kent 2010; Koch, 2013; Lambert, 2008; Lee et al., 2016; McGrath & Rust, 2009; Moore, 2008; Nelson, 2014; Ponder, 2008; Price et al., 1967; Ray, 2017; Taylor-Buckner, 2014; Williams, 2009; Yearwood, 2011). Of these studies, seven have been published in peer-reviewed journals or as a national report (Bastain & Fortner, 2018; Becker, 1987; Fryer, 2018; Gerberich & Prall, 1931; Gibb & Matala, 1962; McGrath & Rust, 2002; Price et al., 1967). One study found student achievement in math and reading declined under specialized instructors, likely due to pedagogical inefficiencies resulting from decreased interactions with students (Fryer, 2018).

Regarding specific subgroups, only four studies within the last 40 years were found. An early study conducted by Becker (1987) found underprivileged students benefitted academically in a self-contained classroom more than their low-income peers in a departmentalized classroom. Twenty years later, Ponder (2008), discovered third and fourth grade students with limited English proficiency benefitted from departmentalized instruction in mathematics. Yearwood (2011) analyzed student achievement data of students in rural Georgia and found statistical significance for the departmentalized setting over the traditional setting, although the setting accounted for only 1% of the variation in the math scores. A more recent study conducted by Jack (2014) in Georgia which examined differences in proficiency of students in urban settings found that students as a whole did not perform better on their mathematics assessment based on one setting or the other nor were their scores predicted by school size or organizational structure. Jack did find, however, that a student's free and reduced lunch status was a significant predictor of mathematics achievement. This study added to the existing body of knowledge by examining overall proficiency in mathematics and proficiency in problem-solving (modeling) and critical thinking skills (reasoning) and filling a major gap by focusing on students considered underprivileged in the Common Core era.

Table 1

Available Research on Instructional Settings and Student Achievement

Author and Year	Type	Subject Area(s)	State	Outcome
Gerberich & Prall, 1931	PR	English, Math	Unknown	Significant
Gould, 1973	D	Social Studies	Iowa	Significant
Gibb & Matala, 1962	PR	Science, Math	New York	Significant
Price et al., 1967	PR	Math	California	No difference
Becker, 1987 ***	PR	Math, English	Pennsylvania	Significant ^
McRath & Rust, 2002	PR	English, Science	Tennessee	No difference
Patton, 2003	D	Math	Florida	Significant
Garcia, 2007	D	Science	Texas	No difference
Lambert, 2008	D	Reading	Oregon	No difference
Moore, 2008	D	Math	Tennessee	Significant
Ponder, 2008 **	D	Math, English	Texas	Significant
Williams, 2009	D	Math	Georgia	Significant
Kent, 2010	D	Reading, Math	Tennessee	No difference
Yearwood, 2011 ***	D	Reading, Math	Georgia	Significant
Koch, 2013	D	Science	Georgia	No difference
Mitchell, 2013	D	Math, English	California	No difference
Jack, 2014 *	D	Math	Georgia	No difference
Nelson, 2014	D	Math	Virginia	No difference
Taylor-Buckner, 2014	D	Math	National	Significant
Lee et al., 2016	D	Math, Reading, Science	Tennessee	No difference
Ray, 2017	D	Math, Reading	Arkansas	No difference
Dymond, 2017	D	Math, English	S. Carolina	No difference
Chennis, 2018	D	Reading	Virginia	No difference
Bastain & Fortner, 2018	PR	Math, Reading, Science	N. Carolina	No difference
Fryer, 2018	PR	Math, Reading	Texas	Significant ^

*Urban settings; **Limited English Proficient Learners; *** Low Income Learners;
^ Traditional
PR = Peer-reviewed, D = dissertation

Results from this study could help district and school-level leadership best leverage human resources and determine which instructional settings are most favorable for student achievement and development of 21st century skills of students living in poverty. Moreover, this research could drive changes in degree plans at the higher education level to include more undergraduate coursework on mathematics teaching and learning or content area minors in mathematics. Ultimately, those changes could have a domino effect on Algebra 1 performance as students become more proficient in elementary school, fewer gaps in knowledge may be prevalent. Fewer gaps in elementary mathematics, specifically fourth grade knowledge of fractions and division, have been linked to success in Algebra 1 (Siegler et al., 2012). This success is critical because research has indicated success in Algebra 1 predicts success in college (Matthews & Farmer, 2008). More importantly, students who are successful in mathematics are more likely to be on track to college readiness, graduate high school, earn a postsecondary degree, and enter career fields in science, technology, health, commerce, and social sciences (Balfanz, Herzog, & Mac Iver, 2007; Lee, 2012; Rose & Betts, 2001; Shapka, Domene, & Keating, 2006). Thus, examining which structures and environments best support student proficiency in elementary school is necessary, especially for students wrapped up in the vicious cycle of poverty.

Research Question

This study aims to answer the following research question:

RQ1: Does the mathematical proficiency of economically disadvantaged fourth-grade students in a departmentalized instructional setting differ from that of economically disadvantaged fourth-grade students in a traditional instructional setting?

Definitions

1. *Achievement gap* – the percentage of students who do not reach academic achievement at each grade level (Bjorklund-Young & Plasman, 2019).

2. *Conceptual understanding* – involves students making connections among operations and structure, developing mathematical reasoning, and engaging in modeling through productive discourse (Hiebert & Grouws, 2007).
3. *Departmentalized models* – instructional setting in which teachers teach one or more subjects to two or more classes of students (Chang et al., 2008, Gerretson et al., 2008; Chennis, 2018; Nelson, 2014; Taylor-Bucker, 2014; Watts, 2012; Williams, 2009; Yearwood, 2011).
4. *Economically disadvantaged* – students who are eligible for free or reduced-price lunch or other public assistance. Used interchangeably with the terms *low-income* or *poverty* (Chingos, 2016; Tileston & Darling, 2009; U.S. Department of Agriculture, 2019).
5. *Mathematical Modeling* – the process individuals use to engage in the problem-solving process involving real-world situations using the mathematics skills they have (English, Fox, & Watters, 2005).
6. *Mathematical Reasoning* – one's ability to connect relationships among concepts and effectively justify conclusions based on evidence or assumptions (Battista, 2017).
7. *Opportunity Gap* – the relationship between a students' socioeconomic status and their achievement (Hanushek, Peterson, Tapley, & Woessman, 2019).
8. *Social constructivist theory* – an explanatory theory for learning based on collaboration, social interaction, and personal thinking processes (Powell & Kalina, 2009; Vygotsky, 1962; Miller, 2011).

9. *Traditional model* – instructional setting in which one teacher is at minimum responsible for teaching all core subjects to one group of students (Chan & Jarman, 2004; Chennis, 2018; Hood, 2009; Nelson, 2014; Reys & Fennel, 2003; Taylor-Bucker, 2014; Watts, 2012; Williams, 2009; Yearwood, 2011).
10. *Zone of proximal development* – the distance between one's threshold for learning independently and the potential to learn with support from adult scaffolding (Vygotsky, 1962).

CHAPTER TWO: LITERATURE REVIEW

Overview

The purpose of this study was to investigate differences in mathematical proficiency of economically disadvantaged fourth-grade students who received instruction in departmentalized instructional settings versus economically disadvantaged students who received instruction in traditional settings. Educators of mathematics at all grade levels must be skilled in the underpinnings of the concepts they teach and know the most effective ways to develop students' modeling, reasoning, and procedural fluency (Reys & Fennel, 2003). When curriculum is presented narrowly in elementary school, the power of mathematics is misrepresented and can negatively affect student attitudes and beliefs (Reys & Fennel, 2003). This poses a significant challenge as the foundation for success in algebra and more challenging mathematics courses is laid in elementary school (Knuth et al., 2016). Organizational settings should be examined to understand better how they impact the development of educator capacity and student proficiency in mathematics. The need for all students to have access to high-quality mathematics teaching and the development of mathematical proficiency forms the rationale for this investigation.

Theoretical Framework

Piaget's (1952) constructivist theory and Vygotsky's (1935/1978) cognitive development theory served as the main theoretical tenants for this study to connect the environment and the role of the educator to how students acquire mathematical knowledge and develop reasoning and modeling skills. Although there are fundamental distinctions between their theories, there are many resemblances, and both theorists have been influential in the practices of education and psychology (Lourenco, 2012). Constructivist views of learning have provided a theoretical foundation for mathematics education research and a framework within which teachers can understand their student (Miller, 2001).

Constructivism

Constructivism is a philosophical theory about how knowledge is acquired and is the fabric of cognitive theory, an explanation for how human brains are structured or utilized during the acquisition of knowledge (Miller, 2011). Piaget (1952), well known in the field of psychology as the father of constructivism, placed heavy emphasis on how individuals reason and interpret new knowledge. He reasoned that knowledge development is an active, adaptive process via methods of assimilation and accommodation of new information integrated into existing cognitive structures. Piaget believed individuals innately either organize experiences into their current cognitive organization and interpret those experiences based on what they already know or adjust their cognitive structures when new information does not fit to meet the demands of the experience (Miller, 2011). These structures gradually develop and are utilized as the filter for one's experiences. According to Piaget's theories, assimilation, or bringing the new into the known, often occurred simultaneously with accommodation because by incorporating new information into older schemata, intelligence continually adjusts to the new elements (Piaget, 1952). Moreover, Piaget posited that children greatly benefit from the experiences of adults or their peers and progress is best supported through discourse for it is through sound discourse that understanding emerges (Piaget, 1952).

Piaget was particularly interested in children's cognitive development and intrigued by the processes children used to arrive at answers to quantitative concepts (Ojose, 2008). He postulated that children's dynamic thought processes are transformed through four distinct developmental stages: sensorimotor, preoperational, concrete operational, and formal operational. Although the stages are formally grouped by age clusters, some children may move through stages at a faster or slower rate depending upon their maturity, ability, or life experiences (Weinert & Helmke, 1998). The experiences in each stage serve a foundational purpose for latter stages, thus stages are not skipped.

Stages of Development

The sensorimotor period, from birth until language is present, is the time children develop relationships between the movement of their bodies and their interaction with the environment. Most input in this stage is received through sensory stimuli and physical movement. Some scholars suggest children in this period understand the concept of number and can rote count (Fuson, 1988). Children should engage in activities that involve counting and support the conceptual understanding of numbers (Ojose, 2008). From this stage, children move to the preoperational stage, roughly ages 2-7, and demonstrate a limited and often vague prevalence of language. Children working in this phase benefit from using concrete materials when completing one-step problem-solving tasks. Teachers of children in grades PreK–2 should know how to effectively question students about the mathematical concepts they are learning to support discovery and construction of knowledge. After students move from the preoperational stage, language becomes more developed in the concrete operations stage, from about ages 7–12. Here children can perceive the world in more than one dimension and begin to develop logical reasoning patterns with concrete objects and strategies. Students in this phase need hands-on activities to engage in concrete understanding of abstract ideas and be shown multiple strategies for mathematical solutions (Burns & Silbey, 2000). Skilled mathematics educators in grades 2-7 are effective at making connections between the mathematical concepts and the work students do with concrete materials, providing multiple strategies to ensure all students learn in a way most meaningful to them. All work done in these first three phases lays the foundation for advanced abstract thinking required in the formal operations stage, from about age 12 and beyond. Here students can identify and analyze problems with additional support from the educator using hypothetical thinking. Recent research has indicated the brain regions responsible for abstract mathematical reasoning continue to develop through late adolescence (Giedd & Rapoport, 2010), suggesting Piaget's concrete operational stage may last much longer than his original theory, thus, pushing the formal operations stage to late teen years.

Although Piaget did not directly connect educational practice to his theories, constructivism and learning stages are relevant to teaching mathematics, for it is essential to understand how students construct information when developing strategies that meet the needs of all students. Drawing from Piagetian theories, activating prior knowledge is critical in learning processes because students will use what they already know to interpret new experiences. One important assumption of the stages of development is that all students do not operate at the same stage. Teachers must learn where students currently function and align instruction accordingly to meet individual needs. Students in the concrete stage and beyond should be given many opportunities to develop mathematical reasoning. Thus, the educator should be skilled at planning stage-appropriate learning experiences to best develop mathematical concepts and not quick to rush students to abstract thinking or using abstract approaches to problem solving before students are ready.

Piaget (1952) believed children must learn mathematics conceptually rather than through rote memorization of facts or procedures and valued thinking processes and mathematical reasoning. Employing a constructivist approach to teaching mathematics requires the educator to serve in the role of facilitator, one who guides students through mathematical logic, the discovery of mathematical ideas, and allows students to teach themselves (Koellner et al., 2007). However, not all student derived constructions are valid, and it is the teacher's role to facilitate discussion and ensure knowledge is constructed correctly (Goos, 2004). As Piaget's theory morphed over the years, his later work highlighted social operations among individuals as an important element to consider in the construction of knowledge, as those interactions play a role in modifying individual cognitive structures (DeVries, 2000)

Cognitive Development Theory

Although much different from Piaget's constructivist views on intelligence development, Vygotsky's (1934/1962) cognitive development theory combined constructivist principles with other social variables, such as social interaction, culture, and language, heavily emphasizing social processes in the development of knowledge. The major distinction between the two theorists lies within how individuals construct knowledge; either solitarily as Piaget reasoned, or socially as Vygotsky argued (Lourenco, 2012). Even after his passing in 1934, educational theorists applied Vygotsky's ideas to extend the work of Piaget and develop a framework for teaching. Like Piaget, Vygotsky valued guided forms of teaching and agreed on the role of the educator as that of a facilitator rather than a director (Walshaw, 2017).

Central to Vygotsky's social constructivist framework is the notion that social interaction, cooperative learning, personal thinking processes, and authentic tasks enhance learning (Powell & Kalina, 2009). Such tasks are replicative of challenges faced in the real world, requiring students to apply newly learned information and construct individual responses (Mueller, 2018). Teacher and student interactions play a key role in forming such essential learning culture supportive of student engagement. Vygotsky believed the development and understanding of new concepts are maximized by children guided by persons with more knowledge than themselves and afforded many opportunities to interact socially with peers (Miller, 2011). He proposed the zone of proximal development (ZPD) notion, the distance between one's threshold for learning independently and the potential to learn with support from adult scaffolding. Scaffolding is gradually withdrawn as the student sustains new understanding and independent task performance is demonstrated (Goos, 2004). Vygotsky argued that student readiness and thoughtful consideration of the ZPD was a pivotal component to the development of intellectual capacity. Because challenging tasks are integral to the growth of cognitive development, children must have the help of an expert individual to support development within the ZPD (Vygotsky, 1934/1962).

Vygotsky's (1934/1962) work in mathematics learning focused primarily on the activities of a group of collaborative learners and the development of mathematical language. Mathematical development via Vygotskian theories is conceptualized through interactive participation and collaboration (Webel, 2013). Vygotsky believed language to be the key to human development and thinking because it is the vehicle through which knowledge is transmitted (Vygotsky, 1934/1962). Thus, the quality of formal and informal dialogue between the student, teacher, and among students is important. Vygotsky was also interested in how children conceptualize words because he believed how words are communicated connects with how those ideas are individually internalized (Powell & Kalina, 2009). It is through the communication process children enter the ZPD to reach their potential of knowledge and reasoning.

Theory to Practice

Constructivist and social constructivist principles applied to learning mathematics has been central to empirical work on mathematics pedagogy. Although the principles do not define ways of teaching, they do establish the importance of the teacher's role in the development of knowledge (Simon, 1995). Mathematics, through the lens of constructivism, is seen as a group of closely and logically connected ideas and understanding those relationships equates to fully knowing mathematics (Good, Grouws, & Ebmeier, 1983). The most effective teachers fully grasp those connections and know how mathematical knowledge progresses while using that knowledge to support development in their students (Sztajn, Confrey, Wilson, & Edgington, 2012). They take ownership of facilitating collaborative discovery among students leading to the construction of community knowledge and mathematical principles (Peterson, Fennema, Carpenter, & Loef, 1989). Every social activity facilitated by the educator, including explanations, can support or hinder conceptual understanding of mathematics as teachers are responsible for making connections between motivations, prior knowledge, competencies, and learning outcomes (Walshaw, 2017). Activities chosen by the educator directly influence the mathematical thinking students engage in and ultimately the proficiencies they reach (Walshaw, 2017). Moreover, the effectiveness of the activity depends heavily on the ability of the educator to make connections among the activity, student's prior knowledge, mathematical theory, and the overarching goals of the lesson (Walshaw, 2017). Thus, the teacher's role is central to learning and requires skill in spontaneously weaving mathematical concepts into instruction (Goos, 2004).

The National Council of Teachers of Mathematics (2000) emphasizes the importance of student social interactions and communication in learning mathematics, supporting Vygotsky's (1934/1962) ideas about learning the mathematical language. Communicating mathematical concepts should occur between and among students, and the teacher and the quality of such dialogue affects the development of students' reasoning (McCrone, 2005; Mercer & Sams, 2006). Through guided, structured experiences of reasoning children become better at reasoning independently; thus, teachers should implement language strategies that support shared understanding among their students as meaning is derived from those social activities (Mercer, 2008; Walshaw, 2017). Scaffolding, peer collaboration, and the teacher's capacity to spontaneously respond to students are important to supporting appropriate ZPD (Goos, 2004).

Children develop meaning for mathematical language only when it is presented in the student’s ZPD (Steele, 1999). Teachers who fail to use appropriate dialogue techniques impact the development of student understanding and new knowledge and diminish the effects of scaffolding (Walshaw, 2017). To contrast, teachers who listen to student ideas and probe for justification of thinking challenge students to explore concepts more deeply, resulting in improved achievement (Firmender, Gavin, & McCoach, 2014). Students must regularly engage in discourse with their peers to develop their reasoning for making conjectures as the practice of mathematical logic is a critical part of participating in mathematics (NCTM, 2014; NCTM, 2000). Classroom environments should support frequent teacher-facilitated mathematical discourse, as quality dialogue about mathematics is a critical piece to deeply understanding mathematics and developing mathematical reasoning (Smith & Stein, 2011; Stein, Engle, Smith, & Hughes, 2008).

Gap in the Literature

Literature on the topic of instructional settings in general is considerably inadequate and the few studies that have been conducted have resulted in contradictory results (Chennis, 2018; Fryer, 2018; Garcia, 2007; Jack, 2014; Kent 2010; Lee et al., 2016; McGrath & Rust, 2009; Moore, 2008; Nelson, 2014; Ray, 2017; Taylor-Bucker, 2014; Williams, 2009; Yearwood, 2011). Regarding specific subgroups, only a few studies have been conducted within the last 40 years. In the early 80s, Becker (1987) found that low-income students performed better academically in a self-contained classroom than their peers in a departmentalized classroom. Many years later, Ponder (2008), examined differences in mathematics achievement of students with limited English proficiency in the two settings and found the departmentalized setting to be more favorable. Another study by Yearwood (2011) explored achievement of students in a rural setting and also found the departmentalized setting more favorable for both language arts and mathematics. More recently, Jack (2014) studied mathematics proficiency of students in urban settings and found neither setting predicted students' achievement.

The issue of instructional settings has been debated among educational professionals, yet little research has been conducted on organizational settings and its effects on teaching effectiveness or student proficiency in mathematics. This study not only investigated student overall mathematical proficiency and procedural fluency in grade level content across instructional settings but also examined competence in modeling and reasoning. Departmentalized formats allow teachers to focus on one or two subjects and lesson plans, reducing workload, stress, and providing more time for the teacher to create better lesson plans (Perrachione, Rosser, & Petersen, 2008; Timms et al., 2007). Educators in departmentalized settings are given the opportunity to focus on one subject, allowing for more time to perfect the craft of teaching mathematics by deeply exploring mathematical content pedagogy (Brobst et al., 2017; Chan & Jarman, 2004; Gerretson et al., 2008; Reys & Fennel, 2003). Moreover, research has indicated teachers' mathematical knowledge for teaching contributes to gains in students' mathematics achievement (Gerretson et al., 2008; Hill, Rowan, & Ball, 2005).

To contrast, traditional models better position educators to provide support in the social development of their students, foster closer student-teacher relationships, and contribute to greater feelings of connectedness and belonging (Anderson, 1962; Baroody, 2017; Chang & Munoz, 2008; Heathers, 1969; McGrath & Rust, 2002; McPartland, 1987, 1990). The social benefits of a traditional model likely contribute to stronger pedagogical methods because educators in this environment know students on a deeper level and can better tailor instruction to meet their needs (Fryer, 2018). Many elementary teachers, however, lack the conceptual understanding of mathematics or the mathematical content pedagogy and such knowledge is critical for student learning and proficiency (Brooks, 2004; NCTM, 2000). Thus, it is valuable to investigate which structures and environments are best suited for educator specialization in mathematics to support student proficiency of the outlined standards.

Related Literature

Proficiency in Mathematics

Much of mathematics education in the 20th century for elementary and middle school students focused on developing students' ability to compute procedurally in arithmetic (Brownell, 1935). However, the discipline of mathematics is not one dimensional and proficiency across all domains equates to the most success in learning mathematics (Ball, 2003). As mathematics continues to evolve in everyday life and in the workplace, students need to engage in mathematics beyond procedural computation and identify the appropriate situations to use algorithms and make sense of why they work (Ball, 1988; NCTM, 2000). To define proficiency in mathematics, Kilpatrick, Swafford, and Findell (2001) of the National Research Council specified five intertwined constructs necessary for successful development. The strands are not developed in isolation, but rather through reinforcement of each other, thus representing the complexity of mathematics. Since their proposal, they have become a framework for understanding mathematical proficiency and were later adapted to become the eight Standards for Math Practice (CCSSI, 2010). As students progress throughout the K-12 standards, they should attain a rich understanding of numbers that involves relationships among numbers and operations and their structures, how numbers are represented with objects, on number lines, and with numerals, and how to apply operations to solve problems (NCTM, 2000).

Conceptual understanding. Conceptual understanding is foundational for new skills and concepts developed in later grades (Bransford, Brown, & Cocking, 2000). Skemp (1978, 2006) argued conceptual understanding, as an essential component to learning mathematics, was more advantageous than procedural knowledge because it is adaptable to new tasks and connects with mathematical representations previously learned. It involves making connections among operations and structure, developing mathematical reasoning, and engaging in modeling through productive discourse (Hiebert & Grouws, 2007). It is essential for students to have a grasp on the mathematics they are learning beyond facts, procedures, and algorithms and understand why ideas are important, how they are organized and connected, and in what contexts they are useful (Bransford et al., 1999). Retention of procedures is best supported through associations students make by their conceptual understandings (Hiebert & Carpetner, 1992; NCTM, 2014). Students engaging in conceptual activities will often use manipulatives to explore and develop the foundation for skills in the later grades.

Procedural fluency. Conceptual understanding and procedural fluency are a mutually beneficial relationship (NCTM, 2014; Rittle-Johnson, 2017; Rittle-Johnson, Sielger, & Alibali, 2001; Smith, Bill, & Raith, 2018). There is extensive evidence to support an iterative, symbiotic view of how conceptual and procedural knowledge are developed, one in which increases in conceptual knowledge affect increases in procedural knowledge and reciprocally (Cowan et al., 2011; Hecht & Vagi, 2010; Schneider, Rittle-Johnson, & Star, 2011). Procedural fluency involves knowledge of how to flexibly compute with mathematical procedures, when to appropriately apply them, and skill in calculating accurately and efficiently (Kilpatrick et al., 2011). In *Principles and Standards for School Mathematics*, NCTM (2000) states, “developing fluency requires balance and connection between conceptual understanding and computational fluency” (p. 35). In elementary school, students learn how to perform basic computations both mentally and using paper and pencil using various strategies for computing with whole numbers. Part of procedural fluency involves using mental estimation strategies to calculate large numbers, as this mirrors real-world tasks in the 21st century. It is vital that students develop both efficiency and accuracy through practice with various computational situations and tools to best build fluency (NCTM, 2000).

Students without procedural fluency struggle to deepen their understanding of mathematical ideas and make connections among mathematical relationships. When students practice procedures without understanding them conceptually, they are more likely to misapply them and develop challenges learning new processes. Furthermore, mathematics becomes compartmentalized and disconnected, limiting a student's ability to apply them in real-world situations (Kilpatrick et al., 2011). Some research suggests teachers use nontraditional arithmetic problems to improve procedural and conceptual knowledge simultaneously (Canobi, 2009). Other study results suggests procedural fluency is best developed through a process-driven approach, one that focuses on the quick retrieval of facts and procedures through properties and operations, rather than an approach that focuses on quick retrieval of answers (McGee et al., 2017; Rohrer, Dedrick, & Burgess, 2014). These studies support NCTM’s (2000) assertion that students who demonstrate procedural fluency can flexibly use numbers when computing and can articulate the mathematical ideas behind the procedures.

Adaptive reasoning. Reasoning encompasses one's ability to connect relationships among concepts and effectively justify conclusions based on evidence or assumptions (Battista, 2017). Reasoning is considered the act of deliberate thought process through logical critical thinking and is a valuable 21st century skill (National Education Association, 2012). The practice of reasoning has been described as the core of mathematics and is applicable across many disciplines (Boaler, 2013). Koestler, Felton, Bieda, and Otten (2013) echo this concept stating, "learning how to argue whether an idea or claim is true or false in a mathematically valid way is an essential part of learning to do mathematics" (p. 30). The development of reasoning is present in children as young as age four supporting their claims with evidence (Alexander, White, & Daugherty, 1997). Early development of logical thought lays the groundwork for more formal arguments in secondary grades involving proofs. Students with solid reasoning skills can navigate concepts, procedures, and solutions to determine if their answer makes sense, and if so, what justification is present as support. The skill of reasoning and sense-making is important because it closely connects with genuine understanding of mathematical ideas and thus a higher likelihood of student engagement (Battista, 2017). When students struggle to make sense of mathematics they often rely on rote learning with no connected concepts (Battista, 2017).

Mueller, Yankelewitz, and Maher (2014) note the development of reasoning involves a combination of observant and responsive teachers, selection of appropriate open-ended tasks, collaboration among students, and a classroom culture supportive of student ideas and conjectures. The teacher's role in promoting student reasoning is valuable, for they must be skilled in asking the right questions that either probe for justifications or proof, guide students through their thought processes, or request factual information (Moyer & Milewicz, 2002; Sahin & Kulm, 2008). Frequent opportunities to discuss solutions and communicating rationale to others fosters the development of reasoning, leading to stronger conceptual understanding (Maher & Martino, 1996).

Strategic competence. Reasoning and sense making provide the foundation for strategic competence, also known as problem-solving (Battista, 2017). Making connections and knowing how to represent knowledge in many ways to effectively problem solve is reflective of a deep understanding of mathematics (NCTM, 2014). Mathematical modeling is the method individuals use to engage in the problem-solving process involving real-world situations applying the mathematics skills they have (English et al., 2005). Thinking mathematically to solve problems involves more than just computation; it requires individuals to interpret situations and determine what models are useful and the most efficient for finding a solution (Lesh & Lehrer, 2003). Students should be flexible throughout the problem-solving process and be able to find multiple solutions to problems through a variety of strategies (Rittle-Johnson & Star, 2007). Once problems have been solved, it is important for individuals to be able to communicate their solutions and determine if their solutions are reasonable.

Problem solving and justifying solutions through frequent opportunities to engage in debate and discourse about concepts is a valuable life skill (Ball, 1988). Skills developed in mathematics courses through exposure to real-world mathematical challenges apply to everyday settings and are vital for college and career success in the 21st century (Kilpatrick et al., 2011). Individuals in the workforce must understand the mathematics they are using and be able to move between different data points and spreadsheets fluently. Moreover, they must be able to estimate and find the inconsistencies in others' reasoning or justifications. Proficiency is developed through sustained experiences of applied problem solving, reasoning, and critiquing the work of others, productive discourse, and making connections between prior and new knowledge (NCTM, 2014).

Productive disposition. Productive disposition refers to how students make sense of mathematics, perceive it as useful and worthwhile, and individual mindsets regarding how one sees themselves as capable of doing mathematics (Kilpatrick et al., 2011). Development of this strand depends on the development of the other four strands and requires frequent opportunities to experience the rewards of perseverance, diligent effort, and to engage in sense-making (Kilpatrick et al., 2011). Frequent problem-solving opportunities promote habits of persistence, inquiry, and confidence in challenging, unfamiliar situations (NCTM, 2000). Students exhibiting productive dispositions recognize the work of mathematics has meaning, value, and relevancy to their lives. Furthermore, they have developed a growth mindset and believe they can be successful in math. As students become more proficient in mathematical concepts and their building blocks, mathematics becomes more sensible (NCTM, 2000).

Students gain confidence in solving challenging problems when they are exposed to them and believe they are capable when given freedom to solve flexibly (Boaler, 2016). Such problems should be open-ended and multidimensional, allowing students to understand how concepts are connected and related (Blad, 2015). Thus, understanding the content better contributes to more positive student attitudes towards mathematics (Kloosterman, Raymond, & Emenaker, 1996). This need for productive disposition positions and healthy mindsets positions the educator in a critical role in its development because they are responsible for fostering classroom cultures, sending positive messages through feedback, grouping students flexibly, and selecting appropriate tasks and assignments (Boaler, 2016). Likewise, teacher attitudes and dispositions towards mathematics can not only impact student achievement but can also affect how students will view themselves as mathematicians and their own attitudes towards the discipline (Dweck, 2008; Mensah, Okyere & Kuranchie, 2013; Hwang, Reyes, & Eccles, 2019).

Mathematics Standards for Learning

Common Core State Standards. Standards for learning have been prevalent in the United States for more than 25 years (Gojak & Miles, 2016). In 1989, the Curriculum and Evaluation Standards for School Mathematics was released to establish a vision for K-12 mathematics and formed the foundation for grade-level standards in many states (Gojak & Miles, 2016; NCTM, 1989). By the turn of the century, all states had adopted specifications that met their criteria for proficiency in all content areas. Inconsistencies across state definitions and criteria led to the beginning stages of development of the Common Core State Standards (CCSS) in 2009 to standardize competence and the enhance the quality of mathematics instruction across the country, ensuring all students are equipped with the knowledge and skills necessary for success in the 21st century (National Governors' Association [NGA], 2010). Led by the NGA and the Council of Chief State School Officers, this initiative began with the college and career readiness standards that address 21st-century skill criteria for students by the time they graduate high school. Common Core standards have been described as a "significant component of systematic improvement in mathematics learning" (NCTM, 2014, p. 1). The inception of the standards meant anticipated instructional shifts aligned to content focus, coherence across standards, and more rigor in the classroom (Gojak & Miles, 2016). As of 2019, 41 states, the District of Columbia, four territories, and Department of Defense schools have adopted the core standards in literacy and mathematics (CCSSI, 2019).

Standards for mathematical practice. In mathematics, the content standards address what students should know and be able to do according to grade level, whereas the Standards for

Mathematical Practice (SMP) address the habits of mind that are utilized to engage in content knowledge (NCTM, 2014). The eight SMPs were adapted from and expanded upon the five strands of proficiency outlined by the National Research Council (Kilpatrick et al., 2011). Although the standards do not define appropriate interventions for students with disabilities or English language learners nor do they account for varying student abilities, needs, or rates of learning, they do provide clear expectations for students aiming toward college and career readiness (NGA, 2010). The eight SMPs are the framework for mathematical thinking within the content standards and describe the longstanding processes that are vital in effective mathematics education across all grade levels (corestandards.org). The math practices are: (1) make sense of problems and persevere in solving them, (2) reason abstractly and quantitatively, (3) construct viable arguments and critique the reasoning of others, (4) model with mathematics, (5) use appropriate tools strategically, (6) attend to precision, and (7) look for and make use of structure (Koestler et al., 2013). The first four standards are the NCTM process standards previously established by the National Council of Teachers of Mathematics (NCTM, 1989). The remaining measures are reflective of the five strands of mathematical proficiency developed by the National Research Council.

Koestler et al. (2013) elaborated upon the eight math practices and highlighted what it means for students to engage in and apply mathematics according to these principles. They described the heart of mathematics as engaging in problem solving and reasoning, often meaning students must reason with numbers and abstract concepts. Students should know how to justify their solutions through explanations of their thinking and be able to find flaws in the reasoning of their peers. They may rely on mathematical structures or patterns when constructing their justifications or evaluating the work of others. Throughout their learning experiences, students will use manipulatives and tools to help them find solutions. They will often engage in mathematical modeling and adjust their problem-solving plans should they find a more appropriate model. Through frequent communication and dialogue, students will need to use precise mathematical language and pay close attention to their calculations to avoid errors.

Fourth grade standards. Content standards in fourth-grade mathematics are disaggregated into five domains: (a) number and operations in base ten, (b) number and operations-fractions, (c) operations and algebraic thinking, (d) measurement and data, and (e), geometry (CCSSI, 2010). Each domain is organized into clusters of related content strands. Fourth-grade content is dedicated to developing fluency with multi-digit multiplication and division, an understanding of fraction equivalence, addition and subtraction with like denominators, multiplication of fractions by whole numbers, and properties of geometric figures (CCSSI, 2010). Place value is extended through the millions and strategies for estimation within operations are established. Students use arrays and area models, place value, and the distributive property as methods for multiplying multi-digit whole numbers. They use the relationship between multiplication and division to find quotients of multi-digit dividends and situationally interpret remainders. Prior knowledge with unit fractions provides the foundation for fourth-grade students to build fractions with larger numerators and previous understandings of operations with whole numbers are applied to operations with fractions. Problems involving measurement and conversions from large numbers to small numbers are introduced and students learn how to interpret and accurately represent data (CCSSI, 2010).

Fourth-grade standards involving fractions and multiplication are directly connected to successful application of many Algebra 1 standards (Bush & Karp, 2013). Early fraction knowledge connects with concepts later developed in middle and high school such as proportional relationships, slope, coefficients, constants, probability models, and solutions (Wu, 2001). Specifically, fraction knowledge at age 10 has a predictive relationship with later achievement in secondary mathematics (Siegler et al., 2012). For a strong foundation in Algebra 1, students must conceptually understand how fractions are comprised as units, how to locate and place them on a number line, and how to compute using the four operations (Bush & Karp, 2013). Misconceptions in Algebra I often arise from a lack of conceptual understanding of fraction content learned in elementary school. Research has indicated students with difficulties in early fraction concepts struggle to make gains and fail to meet mathematics standards by the end of Grade 6 (Jordan, Resnick, Rodrigues, Hansen, & Dyson, 2017).

Assessments of Learning

Federal initiatives. Statewide assessments of learning have been prevalent in the United States for many decades and began in the 1960s when accountability demands first began to surface (Stiggins, 2002). In the 1990s, the United States gave more attention to international assessment programs such as the Program for International Assessment (PISA) to assess how the country measured up against the rest of the world. Later, federal initiatives to improve the quality of education became a hot topic and, in 2002, President Bush signed the No Child Left Behind Act (NCLB). This initiative required annual rigorous standardized testing of every student in Grades 3-8 in mathematics and reading to raise the bar for all students, consequently increasing the instructional demands of educators nationwide. Recently, the Every Student Succeeds Act of 2015 (ESSA) amended the Elementary and Secondary Education Act (ESEA) and repealed NCLB to reduce the number of standardized assessments required of students in grades K-12 (ESSA, 2015). Proponents of the ESSA reform campaign recognized the value in assessments as one of many data points for learning and promoting equity, but rallied for fewer, high-quality assessments that can be administered in a fraction of the time they had previously been (U.S. Department of Education, 2015).

Partnership for Assessment of Readiness for College and Careers. Despite the many shifts in the legislature and the recent reduction in the number of assessments through ESSA, assessment of standards remains a requirement of all fifty states to receive federal funding, maintain accountability, and ensure continuity across school districts and states (U.S. DOE, 2015). Almost half of the states in the United States use the Partnership for Assessment of Readiness for College and Careers (PARCC) or Smarter Balanced Consortium (SBAC) assessments aligned to the Common Core standards (Gewertz, 2019). The PARCC assessment is designed to measure student proficiency in K-12 CCSS content and practice standards in mathematics and English and the degree to which students are college and career ready. Each grade level assessment in mathematics is structured to measure major and supporting content and mathematical process standards across four sub-scores that combine to make up an overall PARCC proficiency score. In Grades 3-8, the claims structure provides an overview of scoring in each of the four sub-scores. Sub-Claim A measures major grade level content with connections to the mathematical processes standards while Sub-Claim B focuses additional and supporting content standards. Sub-claim C assesses the student's ability to construct viable arguments and apply mathematical reasoning while examining mathematical statements and critiquing the reasoning of others. Sub-claim D measures the application of mathematical knowledge through problem solving tasks involving major grade level content standards (PARCC, 2014). The highest possible raw score for the entire exam is 66 points.

PARCC assessments are computer-based and allow for more accommodations, such as assistive technology for students with disabilities, opportunities for students to show their work, and focus on the application of skills (PARCC, 2018). Currently, nine states and entities use PARCC or adapted versions as their statewide summative assessment (PARCC, 2018a). Students scoring overall scaled proficiency scores between 649 and 749 indicate the need for additional support to meet expectations at the next grade level (PARCC, 2018b). Students scoring below 725 demonstrate little understanding of content and are unable to justify their conclusions, reason, or apply problem-solving strategies. Students scoring 750 or above have met or exceeded expectations and are on track for the next grade level (PARCC, 2018b). These scores are indicative of students who are conceptually and procedurally fluent, demonstrate the ability to reason mathematically, and can effectively apply content knowledge to modeling with mathematics through problem-solving.

Smarter Balanced Assessment Consortium. Like the PARCC assessments, Smarter Balanced Assessment Consortium (SBAC) created the Smarter Balanced Assessment System (SBAS) to align with the Common Core State Standards and asses student readiness with the demands of post-secondary college and career demands. The consortium, consisting of 15 states, one territory, and three affiliates, was created around the same time as PARCC and CCSS to meet a need for better measures of student proficiency and progress. However, the test structures of SBAS are much different than that of the PARCC assessment. The test has three components verses the four of PARCC. PARCC uses a fixed delivery model, testing all students at one level of understanding, whereas SBAS uses an adaptive model that adjusts to the level of the student. Questions become progressively more challenging as students continue to answer correctly. Additionally, the SBAS includes interim assessments to measure benchmark performance throughout the year.

Organizational Structures

History and definitions. Various instructional settings can be traced back to the eighteenth century and the one room schoolhouse (Otto & Sanders, 1964). Before the inception of a publicly funded educational system, elementary children were instructed in basements, barns, or old buildings by either parents or a minister (Bunker, 1916). In Boston during the late 17th century, teachers were split according to subject area taught for Grades 1-8. This was the first moment departmentalization was present in U.S. history, although the idea of dividing school disciplines into smaller units was a progressive idea and not commonly implemented. A traditional structure was the most common way to deliver instruction, with children grouped according to grade level or age and instructed in reading and writing by one teacher. It wasn't until the early 19th century that more schools began to divide reading and writing into two separate departments (Bunker, 1916). As instructional settings began to evolve, the concept of dividing reading, writing, and arithmetic among teachers to allow for more specialization became more popular. Many teachers were in favor of departmentalization, citing more enthusiasm for the subject area they specialize in and more time to support the needs of their students (Becker & Gleason, 1927). In the 1930s students were grouped into platoons to allow half-day focus on the arts and the other half focused on core subject areas (Otto & Sanders, 1964). Departmentalization was common practice until the 1940s when traditional settings became the norm again (Anderson, 1962).

Many elementary schools in the present-day United States operate under a traditional, self-contained setting because of the desire to maintain consistency with a single teacher throughout the school day (Jacob & Rockoff, 2011). Traditional, self-contained models are defined as a setting where one teacher is at minimum responsible for teaching all core subjects (mathematics, language arts, science, humanities) to one group of students (Chan & Jarman, 2004; Reys & Fennel, 2003). In the intermediate grades, approximately one-third of fourth and fifth-grade teachers work under departmentalized formats (Jacob & Rockoff, 2011). Departmentalized mathematics teachers in elementary schools are those who teach one or more subjects to two or more classes of students (Chang et al., 2008, Gerretson et al., 2008; Nelson, 2014). The model often differs from structures at the secondary level, but still allows for specialization according to one or more subject areas (Delviscio & Muffs, 2007; Webel, 2017).

Variances in departmentalized structures are used at the elementary level, such as co-teaching, team teaching, looping, or teaching two subjects, but despite those variances, the structure allows for some form of specialization in a content area (Markworth, Brobst, Ohana, & Parker, 2016). Moreover, there is variability in the use of traditional versus departmentalized structures in elementary classrooms. Decisions to organize elementary grade level classes in one format or another are generally made by building-level leadership based on prior experiences, perceptions, and beliefs of the principal and not by district level leadership (Parker, Rakes, & Arndt, 2017).

Specialization and division of labor. The division of labor approach can be traced as far back as the Greek philosopher Plato, who in *The Republic* discussed how the quality of production can be improved by dividing tasks among workers (Plato, 380BC/1943). Plato emphasized the benefits of specialized workers and acknowledged the diverse talents among humans, stating “we must infer that all things are produced more plentifully and easily and of better quality when one man does one thing which is natural to him, and does it at the right time, and leaves other things” (p. 222). Later, the Jewish prophet and leader Nehemiah strategically positioned people to work on rebuilding different sections of the wall of Jerusalem according to their strengths (Nehemiah 3:1-32). This concept was later popularized by economist Adam Smith (1776), well known for his theory on specialization and division of labor, who argued specialized workers are more efficient in their craft and are better able to fine tune their skills, thus maximizing efficiency and productivity. More than a century late, Henry Ford put theory to practice in 1913, and decreased production time of the Model T by breaking assembly line tasks into 84 steps and training workers to be proficient at their one task (Brinkley, 2003)

In the field of education, the concept of specialization and division of labor involves reorganizing human capital to specialize in content areas and maximize teacher strengths. Applying specialization theory, then, it is reasonable to assume teachers should be more productive as a specialist and gain skill in their assigned content areas faster and more deeply than if they were serving as a generalist (Markworth et al., 2016). Specialization in mathematics is relevant because many elementary school teachers have indicated tension in delivering the CCSS due to lack of or limited mathematical content knowledge for teaching (Swars & Chestnutt, 2016). Understanding both content knowledge and how to teach it is key to understanding students' reasoning or conceptualizing different ways of understanding mathematics and is necessary when responding appropriately to student thinking (Hill, Ball, & Schilling, 2008). Thus, by assigning teachers to teach subjects in which they are most effective, potential benefits of increased student achievement and teacher effectiveness could emerge (Jacob & Rockoff, 2011). This idea is supported by research which indicates elementary teachers tend to be more effective in either math or reading (Goldhaber, Cowan, & Walch, 2013). Although the concept of subject-area specialization is not new, the idea is growing in popularity in the United States as elementary teachers are required to have more in depth mathematics content knowledge to maximize delivery of the Common Core standards. Currently, 19 states offer elementary mathematics certifications and endorsements through programs offered at state universities and 10 states are in the process of developing (Elementary Math Specialist and Teacher Leaders Project, 2018).

For students who come from low socioeconomic families, districts must do more to ensure they have access to high quality teachers and instruction (Reardon, 2013). Content area specialists tend to have more success fostering a constructivist learning environment in departmentalized settings, thus leading to more engaged students and more learning (Reid, 2012). Teachers who grasp content well do better at finding ways for all students to access the content despite any gaps in understanding and can better scaffold instruction to meet student needs (Gerretson et al., 2008). This is a valuable skill for students living in poverty in upper elementary school because between 4th and 8th grade many high poverty students begin to quickly fall behind their peers (Beaton et al., 1996). Many underprivileged students enter their mathematics classrooms with major gaps in their content knowledge and understanding (Public Impact, 2018).

Benefits of departmentalization. In the past two decades, students in the United States have underperformed on national and international assessments in mathematics (Barshay, 2018; Desilver, 2017; Gewertz, 2019; Hansen, Levesque, Valant, & Quintero, 2018). Specifically, the steady decline or stagnancy of ACT, NAEP and PISA assessment scores have left education professionals seeking the best way to raise student achievement and increase student competence with the discipline. The shift to specialization models such as departmentalization is often made in response to the pressing need for increased student achievement, accountability demands, more rigorous, standards (Chan & Jarman, 2004; National Mathematics Advisory Panel, 2008; Wu, 2009). Such a shift requires no additional personnel and allows the right environment for focused professional development (Gerretson et al., 2008). Proponents of departmentalization contest it is impossible to develop expertise in multiple subject areas because of lack of time or resources (Chan & Jarman, 2004; Fennell, 2011). However, by restructuring the instructional setting to better support specialization, teachers are afforded increased planning and preparation time, instructional support, focused professional development, and more collaboration (Gerretson et al., 2008). There is more time to refine instructional efforts and plan or revise lessons with depth and creativity; thus, teachers can present content more effectively, efficiently, and with quality (Brobst et al., 2017; Gerretson et al., 2008; Reys & Fennel, 2003; Webel et al., 2017). The departmentalized setting is favorable for content and pedagogical specialization in mathematics through a more narrowed professional development focus, thus increasing educator capacity to deliver content in productive ways that support academic achievement and growth (Fennel, 2011).

Aside from more time, departmentalized settings positively support the psychological needs of the educator. The profession of teaching is complex and cognitively demanding (Peterson et al., 1989). Research has established teacher workload and the amount of planning and preparation can lead to job dissatisfaction, burnout, and disengagement (Timms et al., 2007). Workload is one variable responsible for teacher dissatisfaction with their work environment and increased stress (Klassen, 2010; Timms et al., 2007). Departmentalized models reduce teacher workload, consequently decreasing stress and affording teachers the opportunity to invest their time in meeting every student need (Strohl et al., 2014). Moreover, departmentalized teachers have higher morale compared to their traditional setting counterparts (Strohl et al., 2014). The opportunity to specialize in one subject fosters the development of teacher confidence, competence, and positive attitudes toward the subject, increasing the likelihood that effective instructional methods are used (Lowery, 2000; Wilkins, 2008). When teachers are strategically assigned to content areas where they have yielded high student achievement data, human resources are best leveraged to connect the educator with the subject they are most effective (Goldhaber et al., 2013). Furthermore, when people are given an opportunity to work in areas they enjoy and like, they produce better work (Ackerlund, 1959).

Research has indicated that some of the highest rates of math anxiety are among preservice elementary teachers (Novak & Tassell, 2017). This anxiety negatively impacts student achievement and the amount of time spent preparing math lessons, and leads to ineffectively using math instructional time (Ramirez, Hooper, Kersting, Fergusen, & Yeager, 2018). Additionally, poor experiences with K-12 math education impact preservice teachers' math proficiency (Bekdemir, 2010). Gresham (2018) found math anxiety to continue even after five years of experience with teaching and Aslan (2013) discovered a higher level of math anxiety among in-service teachers versus pre-service teachers. The findings of these researchers seem to suggest a departmentalized model would provide an opportunity for educators a choice to specialize in an area they are the most comfortable teaching.

Benefits of traditional model. Objections to departmentalization are often framed by the notion of student-centered instruction and the claim that the traditional model is more suitable for supporting all students' social-emotional needs and the development of the whole child (Heathers, 1969). Anderson (1962) argued teachers in a specialized model lose opportunities to get to know their students, thus impacting the knowledge needed to tailor instruction and learning experiences to meet the needs of all students. Moreover, on any given day, frequent transitions not only negatively affect knowledge of what practices are most effective for individual students, but they also decrease valuable instruction time (McGrath & Rust, 2002).

Chang and Munoz (2008) found that departmentalized settings negatively impact students' sense of belonging and their feeling of connectedness to their school. This disengagement is likely due to interactions with multiple teachers, making it challenging for a supportive climate to be established (McPartland, 1987, 1990). Further, Chang and Munoz (2008) argue that the elementary school years are the prime time for students to develop attitudes toward school and learning, thus making the departmentalization model inappropriate for younger students. Additionally, students in departmentalized models have rated classroom supportiveness, trust, and respect for teachers significantly lower than their peers in self-contained classrooms (Baroody, 2017). Some research has indicated students in traditional instructional settings have closer student-teacher relationships and higher student engagement, which has been linked to student achievement and motivation (Roorda, Koomen, Spilt, & Oort, 2011). The importance of teacher-student relationships and the connection with various student outcomes have been well documented in the literature (Hernandez et al., 2017; Pianta & Stuhlman, 2004; Sengul, 2019; Silver, Measelle, Armstrong, & Essex, 2005; Thijs & Fleischmann, 2015). This is especially true for students from disadvantaged or at-risk backgrounds (Decker, Dona, & Christenson, 2007).

To contrast, proponents of traditional settings argue teachers in specialized settings have demonstrated less sense of ownership toward their students due to the increased number of students under their instruction (Chang & Munoz, 2008). Time constraints, transitions, lack of colleague collaboration, and scheduling challenges have also been identified as barriers to departmentalized settings (McGrath & Rust 2002; Webel et al., 2017). Such constraints have influenced pre-service teacher preference for self-contained formats due to the flexibility and creativity in planning lessons across subjects (McGrath & Rust, 2002).

Impact on student achievement. Little research exists regarding the effectiveness of instructional settings in elementary school and the research that does exist is inconclusive. Early studies available on student achievement and instructional settings yielded significant differences in certain disciplines in a departmentalized setting (Gerberich & Prall, 1931). Gibb and Matala (1962) found a departmentalized setting to be more favorable for science achievement but not mathematics. One early study investigated three areas of arithmetic skills, reasoning, concepts, and computation, and found a departmentalized model, although more favorable among teachers, was not associated with higher achievement (Price et al., 1967). Later studies have resulted in significant differences in test scores and improved student achievement rates of students who receive instruction in a departmentalized model (Moore, 2008; Nelson, 2014; Williams, 2009; Yearwood, 2011). However, additional studies have found no differences in achievement means per organizational structure (Baroody, 2017; Bastain & Fortner, 2018; Chennis, 2018; Garcia, 2007; Jack, 2014; Kent 2010; Koch, 2013; Lee et al., 2016; McGrath & Rust, 2009; Ray, 2017). Ray (2017) examined instructional settings across Grades 2 through 5 and found inconsistent results. Another study revealed a reverse effect of departmentalization, negatively impacting student achievement presumably due to pedagogical inefficiency resulting from fewer interactions with students (Fryer, 2018). It is difficult to draw a general conclusion regarding the effectiveness of departmentalized models on student achievement due to inconsistency in the findings in existent literature, which illuminates the need for this research project.

Summary

Students in the 21st century need access to high-quality mathematics teaching at an early age because the development of proficiency in mathematics positions students for success in the 21st century (Reys & Fennel, 2003). Problem-solving and reasoning skills learned in mathematics courses are transferrable to any industry or career and are vital for college and career success (Kilpatrick et al., 2011). Mathematical proficiency is multifaceted and more profound than merely calculating numbers. An interconnected weave of strands, it involves the concrete understanding of mathematical concepts, fluency and accuracy with calculations, connecting relationships among concepts, problem-solving, and exhibiting a productive, growth mindset (Boaler, 2016; Kilpatrick et al., 2011; NCTM, 2014). A deep understanding of mathematics content and pedagogy of the educator is a key variable in the development of proficiency among students.

Theories of constructivism and socio-cultural theory were chosen as the main theoretical tenants for this research study to link the instructional setting to the development of students' mathematical proficiency, modeling, and reasoning. Although the two theories have distinct characteristics, both Vygotsky and Piaget's cognitive development theories position the educator as a facilitator of knowledge, one who supports mathematical discourse, makes sense of and develops student reasoning, builds connections among mathematical ideas, and fosters a community of learners with productive dispositions. Educators must understand how students develop knowledge through Piaget's stages of development and provide frequent opportunities for students in the concrete operational stage to engage with mathematics using manipulatives (Ojose, 2008). Moreover, they must know how to activate prior knowledge and how to effectively position student learning experiences and discussions within their individual zone of proximal development. A teacher's shallow understanding of mathematics does not support these ideas (Reys & Fennel, 2003).

Researchers have not confirmed which instructional setting is superior to academic achievement; however, there is evidence that self-contained models support the development of the whole child, foster stronger teacher-student relationships, and contribute to students feeling more connected at their schools (Anderson, 1926; Baroody, 2017; Heathers, 1969; McGrath & Rust, 2002; McPartland, 1987, 1990; Munoz, 2008). However, departmentalized models lend themselves to better educator specialization by allowing for additional time to explore mathematical content more deeply, craft better lesson plans, and reduce teacher workload (Brobst et al., 2017; Chan & Jarman, 2004; Gerretson et al., 2008; Perrachione et al., 2008; Reys & Fennel, 2003; Timms et al., 2007).

As research continues to connect teachers' mathematical knowledge for teaching with student achievement, it is important to explore various organizational models that best support the development of a teacher specialist (Gerretson et al., 2008; Hill et al., 2005). Inconclusive results in the literature regarding the impact of instructional setting on achievement and the major gap regarding special subgroups such as underprivileged students warrant the need for continued research to ascertain what differences settings make in the learning process toward mathematical proficiency. This study has added to the existing body of literature by examining to what degree instructional settings impact low-income students' overall mathematical proficiency, modeling, and reasoning skills as measured by the PARCC assessment.

CHAPTER THREE: METHODS

Overview

The purpose of this causal-comparative study was to determine if there is a difference in economically disadvantaged 4th-grade students' mathematical proficiency when receiving instruction in a departmentalized setting versus a traditional setting. This study was designed to evaluate participants' achievement in overall mathematics proficiency, reasoning proficiency, and modeling proficiency as measured by the Partnership for Assessment of Readiness for College and Careers (PARCC) mathematics assessment. Chapter 3 contains a detailed description of procedures and aspects related to the methods chosen to conduct the study. Identification of participants, methods of conducting research, instrumentation, and methods used to perform the study and analysis of data are discussed.

Research Design

A causal-comparative quantitative research design was used to determine if there is a difference in economically disadvantaged fourth-grade students' mathematics proficiency scores based on instructional setting as measured by the 2018-2019 PARCC mathematics assessment. This research design was appropriate because the investigation was non-experimental, archival data were used, and possible cause-and-effect relationships were examined by forming groups of individuals by the independent variable and investigating if those groups differed on one or more dependent variables (Gall, Gall, & Borg, 2007). In this study, the researcher sought to determine if differences in PARCC mathematics proficiency scores existed among economically disadvantaged students receiving instruction in either a departmentalized or traditional setting. Quantitative methods involving the collection, analyzation, and interpretation of data in a study were used in this study. Specifically, this involved identifying the target population, obtaining permission from the organization, determining what information to collect, and selecting reliable and valid quantitative instruments (Creswell, 2015). Nonprobability sampling was appropriate for this study because the participants were convenient and easy to access. Comparison groups from the sample were formed through a selection process because it was not possible for students to be randomly assigned to the two instructional setting types. Students belonged to previously established groups; thus, variables could not be manipulated (Gall et al., 2007).

The independent variable, instructional setting, formed the foundation for this study. Instructional setting involved two levels, departmentalized and traditional. Departmentalized instructional settings are those in which an educator teaches one or two subjects to multiple groups of students. A traditional instructional setting is one in which an educator teaches more than two subjects to one group of students for most of the school day. Overall mathematical proficiency scores, modeling proficiency scores, and reasoning proficiency scores were the dependent variables for this study. Mathematical modeling was defined as a problem-solving process involving real-world situations where individuals apply mathematical approaches and interpret their results in the context of the situation (CCSSI, 2010; Kilpatrick et al., 2011; NCTM, 2013). Mathematical reasoning was defined as the ability to use valid, logical reasoning to establish whether mathematical statements and justifications are accurate or flawed (CCSSI, 2010; Kilpatrick et al., 2011; NCTM, 2013).

Research Question

This study was conducted to answer the following research question:

RQ1: Does the mathematical proficiency of economically disadvantaged 4th-grade students in a departmentalized instructional setting differ from that of economically disadvantaged 4th-grade students in a traditional instructional setting?

Hypotheses

The null hypotheses for this study were:

$H_0$1: There is no statistically significant difference in mean overall mathematical proficiency between economically disadvantaged 4th-grade students in departmentalized versus traditional instructional settings.

$H_0$2: There is no statistically significant difference in median mathematical reasoning proficiency between economically disadvantaged 4th-grade students in departmentalized versus traditional instructional settings.

$H_0$3: There is no statistically significant difference in median mathematical modeling proficiency between economically disadvantaged 4th-grade students in departmentalized versus traditional instructional settings.

Participants and Setting

Participants for this study were drawn from a cluster sample of 4th-grade students from 78 public elementary schools in a large suburban school district in central Maryland during the 2018-2019 school year. Fourth-grade students identified as economically disadvantaged were chosen for three reasons: (1) this cohort of students in Maryland had been exposed to the Common Core Standards since kindergarten, (2) because the gap between students from low-income families and their economically advantaged peers had not narrowed since Maryland began implementing the Common Core standards in 2015 (MSDE, 2019), and (3) achievement gaps in mathematics grow rapidly between fourth and eighth grade (Balfanz & Byrnes, 2002). Economically disadvantaged students were defined as students who receive either free or reduced lunches as part of the National School Lunch Program as per the USDA’s guidelines (Tileston & Darling, 2009; USDA, 2019). Household income limits for this category depended upon household size and were determined by multiplying the Federal poverty rate by 1.30 for free meals and 1.85 for reduced meals (USDA, 2019).

Cluster sampling involves selecting naturally occurring groups of individuals rather than individuals from a defined population (Gall et al., 2007). There were approximately 6,685 fourth grade students in this school district and 2,319 fourth-grade students identified as economically disadvantaged from which to obtain the sample (Maryland State Department of Education, 2018). A minimum sample size of 100 students was required for a medium effect size with a statistical power of 0.7 at the 0.05 alpha level of significance for an independent samples *t*-test (Gall et al., 2007; Warner, 2013). All elementary schools within this district grouped students by pre-kindergarten through fifth-grade classrooms. The total population of individual elementary schools ranged from 809 to 165, with a mean student population of 487 (MSDE, 2019). Student demographics for elementary schools in this district consisted of 56% Caucasian, 20% African American, 14% Hispanic/Latino, 6% Bi-Racial, <1% American Indian, and <1% Native Hawaiian. Males and females represented 51% and 49% of the population, respectively. Approximately 50% of the elementary schools used some form of departmentalization in their schools and varied by content area (School district email correspondence, 2018). Of the educators in this district, 60% held an Advanced Professional Certificate and 30% held a Standard Professional Certificate. Three special education schools were excluded from the study because they formed instruction via modified content standards and curriculum. All charter schools were excluded because they may have utilized different curriculum for mathematics instruction.

The district follows the Common Core State Standards (CCSS) for mathematics in all grades and all elementary teachers are required to plan instruction from a district-created curriculum framed by the Concrete-Representational-Abstract (CRA) model. The curriculum provides a balance of conceptual, application, and fluency practice to support rigor. Content domains for mathematics in fourth grade include number and operations in base ten, fractions, data analysis, measurement, geometry, and algebraic thinking. 2017 National Assessment of Educational Progress (NAEP) 4th-grade mathematics scores for Maryland public schools were not significantly different from the national average (NAEP, 2017).

Instrumentation

Administrator Survey

A process implemented by a previous researcher and modified for this study was used to identify groups (Yearwood, 2011). The researcher first submitted a survey to the school district for approval and upon approval the school district emailed the survey to the 80 administrators of elementary schools in the selected school district (See Appendix A). A response return rate between 50-78% was expected, or approximately 40 to 62 administrators (Creswell, 2015; Saleh & Bista, 2017). The actual response return rate was 39%, or 31. The researcher also had access to an additional survey sent by district leadership in the mathematics department to each elementary math lead (See Appendix C). Information from this survey was used to cross reference responses from the researcher's survey and to identify additional schools to create even groups based on demographic information for data analysis. The results of both surveys were used to label groups for the study.

PARCC Mathematics Assessment

Proficiency was measured using archival data from the 2018-2019 PARCC Grade 4 Mathematics Assessment. The 2018-2019 school year was the final year Maryland used the PARCC assessment to meet accountability guidelines outlined in ESSA. Although the test for this school year was listed under the Maryland State Department of Education website as MCAP, the test for the 2018-2019 school year was still under the PARCC framework. For administration periods beyond 2019, Maryland school districts will administer the MCAP assessment, which was still under development at this time.

Development of PARCC began in 2010 through Race to the Top assessment funds awarded to the PARCC consortium by the U.S. Department of Education to measure student achievement in language arts and mathematics (PARCC, 2018). Hundreds of K-12 and postsecondary educators, assessment experts, and bias experts were involved in its construction to best benchmark to the newly developed and extensively researched CCSS, Process Standards, and to those standards prevalent in international high-performing nations (CCSSI, 2010). The CCSS were created to meet the demands of first-year college courses, academic content knowledge, critical thinking skills, and metacognitive competencies. During the 2018-2019 school year, entities using PARCC in its entirety or adapted versions as their statewide summative performance assessment were DC, Illinois, Louisiana, Maryland, Massachusetts, New Jersey, New Mexico, DoDEA, and the Bureau of Indian Education (PARCC, 2018).

The PARCC assessment has undergone extensive reliability and validity studies. Major research organizations have determined PARCC is rigorous, aligns with high quality instruction, provides better access for students who need supports, is close to NAEP college readiness expectations, and is a strong predictor of success in college (Batel & Sargrad, 2016; Doorey & Polikoff, 2016; McLellan, Jilliam, & Bassett, 2015; Nichols-Barrer, Place, Dillon, & Gill, 2015; Phillips, 2016). Construct validity is present due to the involvement of hundreds of educators, assessment experts, and bias and sensitivity experts. There are high intercorrelations among the four sub-claims, indicating the assessment is unidimensional with internal validity (Pearson, 2017). Cronbach's reliability coefficients for the overall assessment and sub-claims C and D are listed in Table 2. Reliabilities for the reasoning and modeling sub-claims are lower due to the number of items assessed in each category. The more items in an instrument, the more likely internal consistency is achieved.

Table 2

Cronbach's Reliability Coefficients—PARCC

Construct	Total Tasks	Reliability	Rating
Overall	44	α = 0.93	Excellent
Reasoning (C)	4	α = 0.76	Good
Modeling (D)	3	α = 0.61	Moderate

Inter-rater reliability as measured via Pearson's ePEN2 scoring system for hand-scored portions of the exam ranged from 97% to 100%. Hand-scored portions involved both Type II (reasoning) and Type III (modeling) tasks (Pearson, 2017). Training involved carefully developed scorer training materials from review meetings with administrators and educators from PARCC states. During training, scorers reviewed training sets and rationale for scores assigned. Responses used in training sets represented typical approaches to the task and were arranged to reflect a continuum of proficiency. All scorers went through a system of anchor, practice, and qualification sets before receiving scorer qualification. PARCC scoring methodology must be accurately shown during the qualification process and matched with the PARCC-approved score at a percentage agreed by PARCC to qualify as a scorer.

Scores on four sub-claims determined the overall PARCC score: (a) major content with connections to practice, (b) additional and supporting content with connections to practice, (c) expressing mathematical reasoning, and (d) modeling/application. In 2019, 39.4% of Maryland fourth-graders were proficient on the mathematics portion of the PARCC exam, with no improvement from the previous test administration (MSDE, 2019). For students considered economically disadvantaged, only 21.3% were considered proficient, a 5% increase from the previous year (MSDE, 2019). Beginning in 2016, testing has been administered completely computer-based through the platform system TestNav provided by Pearson. Fourth-grade students receive 60 minutes to complete each unit, a total of three units taken over three days. The assessment has 40 tasks totaling 66 points and represents the three task types. Table 3 shows an overview of tasks types and point values (Pearson, 2017).

Table 3

Grade 4 High Level Blueprint and Task Types

Task Type	Description	Sub-Claim	No. of Items	Total Points
Type 1	Conceptual understanding, fluency, application	A&B	33	40
Type 2	Written arguments, justifications, critique of reasoning	C	4	14
Type 3	Modeling/application	D	3	12

PARCC was administered annually between late April and early June of each school year. The Maryland State Department of Education (MSDE) provides training to all district training coordinators who are responsible for providing training to school administrators, examiners, and proctors. Training involves an overview of the testing manual, confidentiality procedures, test security, and accommodations for eligible students. School districts received PARCC data disaggregated by student, class, school, and state. Each students' PARCC scores were further disaggregated by the CCSS content areas for their grade level and by the four sub-claims (Pearson, 2017). Raw scores were weighted against a scale to allow for accurate comparison across test forms and administration years (Pearson, 2017). Scale scores were used to determine where students lay along the performance level continuum. Table 4 shows performance levels based on scaled scores.

Table 4

PARCC Mathematics Performance Levels

Level	Score Range	Description
Level 1	650-699	Did not meet expectations
Level 2	700-724	Partially met expectations
Level 3	725-749	Approached expectations
Level 4	750-802	Met expectations
Level 5	803-850	Exceeded expectations

The major work of fourth grade under the CCSS involves using all four operations to solve problems through place value models and relationships among operations. Students are expected to achieve fluency with addition and subtraction with numbers less than or equal to one million using the standard algorithm. Understanding of fractions continues to develop from third grade and students begin to build fractions from unit fractions, explore fraction equivalence, ordering, and decimal notation for fractions in tenths and hundredths. Development of major content knowledge is supported by instruction in factors and multiples, measurement conversions, and representation and interpretation of data. Additional content involves pattern analysis, angles and their measurements, and using lines and angles to classify shapes.

Procedures

Prior to data collection and analysis, the researcher obtained permission to conduct the study. The researcher first secured approval from the school district by completing an application for external research through the school district’s data office (See Appendix D). Upon school district approval, the researcher sought expedited approval through Liberty University’s Institutional Review Board (See Appendix E). An expedited application was appropriate because archival performance data were used in the analysis. Upon IRB approval, the researcher submitted the research survey to the school district for dissemination to the elementary school administrators via email for the purpose of obtaining information about the instructional setting used in their fourth-grade classrooms. The email included a brief explanation of the study, its purpose, and detailed definitions of departmentalized and traditional instructional settings. The researcher explained that a departmentalized setting is one where students receive instruction in their core content areas (mathematics, science, history, English language arts) from more than one educator who teaches in their area of specialization, no more than two content areas total. A traditional setting was defined in the email as one where students receive instruction in all core subject areas from a single teacher for the entire school year. The email requested administrators to respond to a secure Google Form questionnaire link (See Appendix A). The Google Form was by invitation only to ensure the confidentiality of the respondents. A hard copy was printed and stored in a secure file and once completed the responses on the Google Form were deleted. Additionally, the school district personnel from the elementary mathematics office sent a survey, internal to the agency, to all elementary math leads to identify forms of departmentalization used in their schools (See Appendix C). Results from this survey were used to cross reference results from the researcher's survey and identify any additional schools that could be used to balance the number of participants in each of the two groups for statistical analysis.

Responses were used to segregate data into two comparison groups: (a) schools using a traditional setting during the 2018-2019 school year and (b) schools using departmentalization during the 2018-2019 school year. Once initial comparison groups were compiled, disaggregated reports of each school's mathematics PARCC scores from 2018-2019 filtered by Free and Reduced Lunch (FARMS) status and by current grade level (Grade 5) were retrieved from the district data platform to include student demographic data. Then, schools were selected for analysis by matching demographic and geographic location information of the 18 schools in the departmentalized group to the traditional group to ensure balance in the number of students receiving special education services, students identified as limited English proficiency, and racial demographics. Matching was done to the departmentalized group because fewer schools reported utilizing a departmentalized structure than a traditional structure. Schools were first matched by the geographically defined attendance area and either all or none of scores from a school were used depending on how it impacted the balance of numbers in each group. This was done to control for confounding variables that could potentially be responsible for differences in scores. Additionally, each group had three title one schools. Of the schools selected for analysis, students who received instruction in a departmentalized setting were assigned to Group 1 and students who received instruction in a traditional setting were assigned to Group 2. Of the student scores in each group, only students who had scores for both the 3rd grade and 4th grade PARCC assessment were used in analysis. This was done to identify if any significant differences were present in prior year's third-grade PARCC scores for the purpose of determining whether a covariate would be necessary in statistical analysis.

Data Analysis

Descriptive statistics were computed for student demographics and PARCC mathematics scores for each comparison group. Three analyses were conducted in this study. First, a *t*-test was used to determine if the mean scores of the two instructional setting groups significantly differed on the dependent variable *overall PARCC mathematics proficiency score*. A *t*-test was appropriate for this study because it evaluates whether the population means differ significantly between two independent groups (Warner, 2013). Second, a nonparametric Mann-Whitney U analysis was used to determine if the distribution of scores for the two groups differed on the other two dependent ordinal variables, *modeling proficiency* and *reasoning proficiency* (Gall et al., 2007; Warner, 2013). This analysis was appropriate because the dependent variables were scored as a 1, 2, or 3 where (1) indicated proficient, (2) was approaching proficient, and (3) was not proficient (PARCC, 2015). Ordinal data cannot be analyzed in an Analysis of Variance (ANOVA) or *t*-test. However, the Mann-Whitney U test determines if there are differences between groups on a continuous or ordinal dependent variable (Mann & Whitney, 1947). If the population distributions are the same, the analysis examines the medians to determine if there are any differences. If the distributions are not the same, the analysis ranks the scores and determines to what extent the distributions are different (Laerd Statistics, 2015; Mann & Whitney, 1947).

The independent samples *t*-test required consideration of six assumptions. Three of the assumptions required the data to meet certain characteristics, while the other three assumptions could be tested in statistical software. Data must be measured at the continuous level, there must be one independent variable with only two levels, and individual data do not belong to both groups. The other three assumptions for the *t*-test were tested using SPSS software to evaluate normal distribution, outliers, and equal variances (Warner, 2013). Unusual scores were visually inspected using boxplots and outliers were examined to determine if it was necessary to remove them. Normality was determined tenable using histograms and the Kolmogorov-Smirnov test at a significance level of $\alpha > 0.05$. The final assumption test involved using the F ratio for Levene's test and looking for a significance level greater than 0.05 to determine if the spread of scores around the mean was equal across both groups of the independent variable. Effect size was determined by analyzing Cohen’s d (Warner, 2013).

Although the Mann-Whitney U analysis does not rely on any assumptions about the shape of the distributions or variance of population cores, there are four assumptions to consider before performing the analysis. First, there must be one dependent variable that is measured at the continuous or ordinal level. Second, there must be one independent variable with two categorical groups. Third, there should be no relationship between the data in either independent variable group. Finally, the distribution of scores for both groups of the independent variable either have the same shape or a different shape. Distributions that are the same would involve an analysis of the medians. Distributions that are different would involve an analysis of the distributions (Laerd Statistics, 2015).

CHAPTER FOUR: FINDINGS

Overview

The purpose of this causal-comparative, quantitative study was to determine if there was a statistically significant difference in the overall mathematics proficiency, modeling proficiency, and reasoning proficiency scores of economically disadvantaged fourth grade students who received instruction in a departmentalized setting versus economically disadvantaged fourth grade students receiving instruction in a traditional setting as measured by the 2018-2019 PARCC scores. This chapter begins with descriptive statistics for each dependent variable and follows with appropriate assumption testing reporting for an independent samples *t*-test and a Mann-Whitney U analysis. Next, the results of the *t*-test and Mann-Whitney U are presented for each null hypothesis to examine the effect of instructional settings on various student achievement factors and a summary of results follows thereafter.

Research Question

The research question for this study was:

RQ1: Does the mathematical proficiency of economically disadvantaged 4th-grade students in a departmentalized instructional setting differ from that of economically disadvantaged 4th-grade students in a traditional instructional setting?

Null Hypotheses

The null hypotheses for this study were:

$H_0$1: There is no significant difference in overall mathematical proficiency between economically disadvantaged 4th-grade students in departmentalized versus traditional instructional settings.

$H_0$2: There is no significant difference in mathematical reasoning proficiency between economically disadvantaged 4th-grade students in departmentalized versus traditional instructional settings.

$H_0$3: There is no significant difference in mathematical modeling proficiency between economically disadvantaged 4th-grade students in departmentalized versus traditional instructional settings

Descriptive Statistics

Data obtained for the dependent variables, overall proficiency, reasoning, and modeling, can be found in Tables 6 through 8, while Table 5 summarizes demographic information for the two settings.

Table 5

Demographic Information for Participant Data

Setting	*n*	SWD	LEP	AA	W	Asian	Multi	His	AI
Departmentalized	291	44	49	88	113	11	22	55	2
Traditional	289	49	48	75	105	8	31	70	0

Note. SWD = Students with Disabilities; LEP = Limited English Proficient; AA = African American; W = White; His = Hispanic; AI = American Indian.

Table 6
Descriptive Statistics for Modeling and Reasoning Proficiency 18–19

Setting	*n*	Median	Median Rank
Modeling			
Departmentalized	291	3.00	294.45
Traditional	289	2.00	286.53
Reasoning			
Departmentalized	291	2.00	285.81
Traditional	289	2.00	295.22

Table 7

Demographics and Mean Overall Proficiency per School—Departmentalized Group

School	*n*	SWD	LEP	AA	W	His	Multi	Asian	AI	Mean
A*	29	6	4	23	1	5	0	0	0	719
B	2	0	1	0	1	1	0	0	0	733
C	2	1	1	0	1	0	1	0	0	736
D	14	2	5	5	8	5	1	0	0	735
E	6	0	2	2	1	1	1	1	0	740
F	11	2	1	0	8	2	1	0	0	728
G	2	0	0	1	1	0	0	0	0	727
H	12	1	2	0	9	1	1	1	0	736
I*	36	10	7	8	14	11	2	1	0	725
J	23	1	8	10	3	4	2	4	0	733
K	10	0	0	1	7	0	1	1	0	733
L*	54	7	9	12	24	13	5	0	0	740
M	9	3	0	3	3	0	2	1	1	722
N	17	2	0	3	11	0	2	0	0	747
O	15	2	4	10	1	3	0	1	0	727
P	5	2	1	3	1	1	0	0	0	719
Q	38	5	3	8	19	7	3	1	1	726
R	6	0	1	4	0	1	0	0	0	744
Totals	291	44	49	93	113	55	22	11	2	731

Table 8

Demographics and Mean Overall Proficiency per School—Traditional Group

School	*n*	SWD	LEP	AA	W	His	Multi	Asian	AI	Mean
S*	39	5	4	10	15	11	3	0	0	724
T	11	0	1	1	8	1	1	0	0	738
U	12	1	3	0	5	3	3	1	0	746
V	14	3	2	4	2	6	1	1	0	736
W*	31	5	6	9	11	9	1	1	0	716
X	30	9	2	3	18	4	5	0	0	720
Y	3	0	0	1	2	0	0	0	0	759
Z	2	0	2	0	0	2	0	0	0	712
AA	32	6	3	17	5	4	6	0	0	719

Table 8 continued

School	*n*	SWD	LEP	AA	W	His	Multi	Asian	AI	Mean
BB	47	11	6	11	20	10	5	1	0	729
CC *	42	6	8	11	16	10	2	1	0	718
DD	13	2	2	6	3	1	3	0	0	726
EE	13	1	9	2	0	9	1	1	0	736
Totals	289	49	48	75	105	70	31	6	0	725

*Title 1 School

Results

Data Screening

For null hypothesis one, outliers were determined by visually inspecting boxplots for both groups of the independent variable. In the departmentalized group, three mild outliers scored 850, 830, and 654. These outliers were not considered extreme enough to remove from the analysis. Moreover, 3rd grade scores were analyzed prior to conducting the *t*-test and it was determined there was no significant difference in those scores and a covariate was not necessary, $t(578) = 1.423$, $p = 0.155$. See Figure 1 for box and whiskers plot.

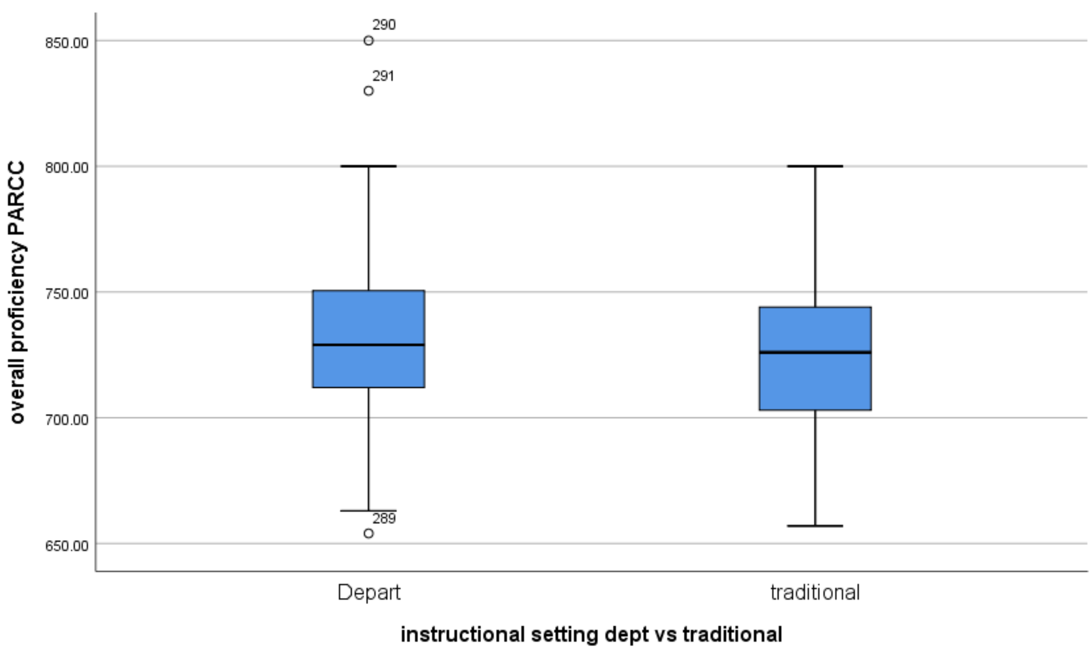

Figure 1. Box and Whiskers Plot for 2018–2019 Overall Proficiency Scores.

Assumptions

For null hypothesis one, the independent samples *t*-test required normal distribution of data and homogeneity of variances. The assumption of normality and normal distribution was examined and determined tenable using a Komlogorov-Smirnov test and a visual inspection of histograms. See Figures 2 and 3 below for histograms and Table 9 for normality testing. Homogeneity of variances was examined using the Levene test, $F = 0.132$, $p = 0.16$; this indicated no significant violation of the equal variance assumption.

Table 9

Kolmogorov-Smirnov Test for Normality for Overall Proficiency Scores 2018–2019

Instructional Setting	Statistic	*df*	Significance
Departmentalized	.051	291	.070
Traditional	.049	289	.090

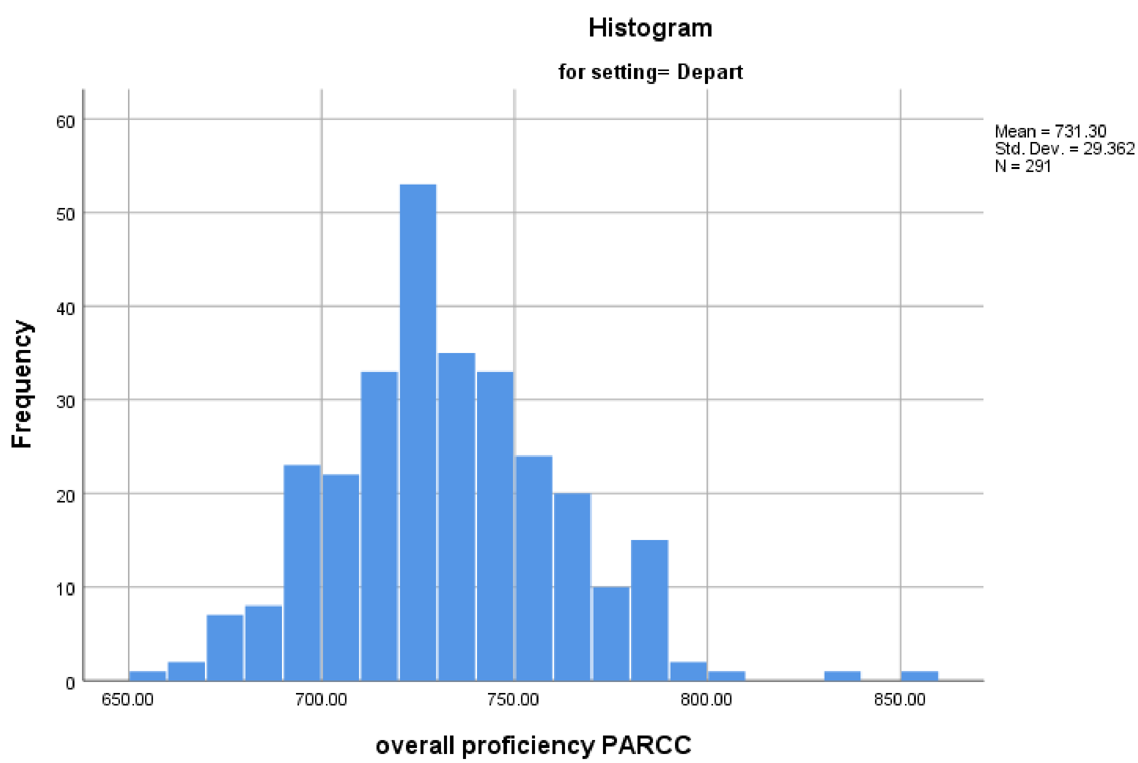

Figure 2. 2018–2019 Overall Proficiency Distribution for Departmentalized Setting.

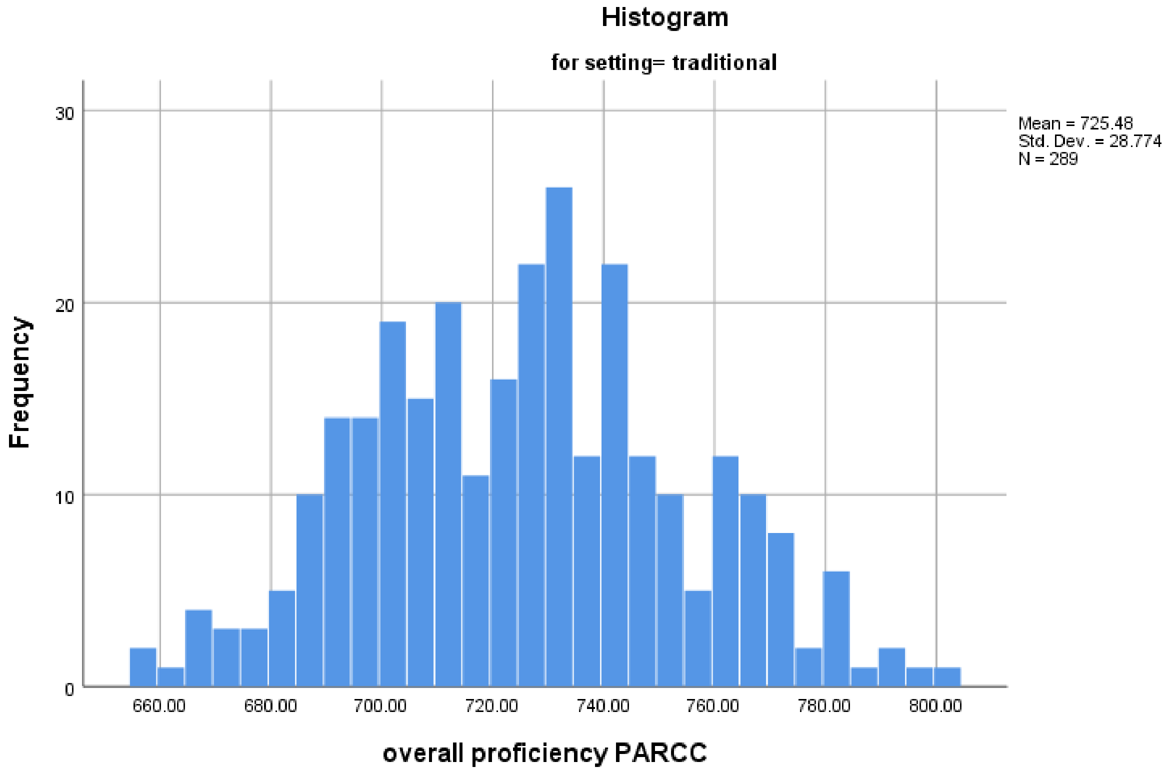

Figure 3. 2018–2019 Overall Proficiency Distribution for Traditional Setting.

For null hypotheses two and three, the Mann-Whitney U analyses required four assumptions to be met before proceeding with the analyses. First, the data are considered ordinal because the modeling and reasoning scores are listed as a (3) does not meet, (2) partially meets, and (1) meets or exceeds expectations. Second, all data items are considered independent of each other because students are administered the PARCC assessment through an online platform and login with individual credentials. Third, the independent variable, instructional setting, has two categorical independent groups, departmentalized and traditional. Finally, distributions of the two instructional setting groups were determined to be similarly shaped as assessed by visual inspection for both modeling and reasoning scores and by performing the Mann-Whitney U analysis. Those results are interpreted in the section below headed, Results for Null Hypothesis Two and Three.

Results for Null Hypothesis One

An independent samples *t*-test was conducted to assess whether the mean 2018-2019 overall mathematics achievement score (PARCC) differed significantly for a group of 289 economically disadvantaged students who received instruction in a departmentalized setting compared to a group of 291 economically disadvantaged students who received instruction in a traditional setting. The mean overall PARCC score for the departmentalized group (M = 731.30 $\pm$ 1.72, SD = 29.36) was about 6 points higher than the mean overall PARCC score for the traditional group (M = 725.48 $\pm$ 1.69, SD = 28.77), and statistically significant, $t(578) = 2.41$, $p = .02$, two-tailed. The effect size, as indexed by Cohen's *d*, was 0.20; this indicates the departmentalized instructional setting had a small effect on the overall PARCC score (Warner, 2013). The 95% confidence interval for the difference between the sample means had a lower bound of 1.07 and an upper bound of 10.55. See Table 10 for summary.

Table 10

Summary Table for Null Hypothesis 1

	t	*df*	Sig.	Mean Difference	Std. Error	95% Confidence Interval	
						Lower	Upper
Overall Proficiency	2.41	578	.02	5.81	2.41	1.07	10.55

Results for Null Hypotheses Two and Three

Mann-Whitney U tests were performed to determine if there were differences in modeling and reasoning scores between students receiving instruction in departmentalized versus traditional settings. Distributions of the modeling and reasoning scores for both groups were similar, as assessed by visual inspection. See Figures 4 and 5 below. The modeling scores were not statistically significantly different between students in the departmentalized group (*Mdn* =

3.00) and students in the traditional group (*Mdn* = 2.00), *U* = 40,901.50, *z* = -0.62, *p* =0.53, *p* > 0.05. The reasoning scores were also not statistically significantly different based on setting, and the departmentalized group's median (*Mdn* = 2.00) was the same as the traditional group(*Mdn* = 2.00), *U* =43,414.50 , z = 0.73, *p* = 0.47, *p* > 0.05. See Table 11 for summary.

Table 11

Summary Table for Null Hypotheses 2 and 3

	Modeling	Reasoning
Mann Whitney U	40,901.50	43,414.50
Wilcoxon W	82,806.50	85,319.50
z	-0.62	0.73
Standard Error	1,846.39	1,874.16
Asymp. Sig (2-tailed)	0.53	0.47

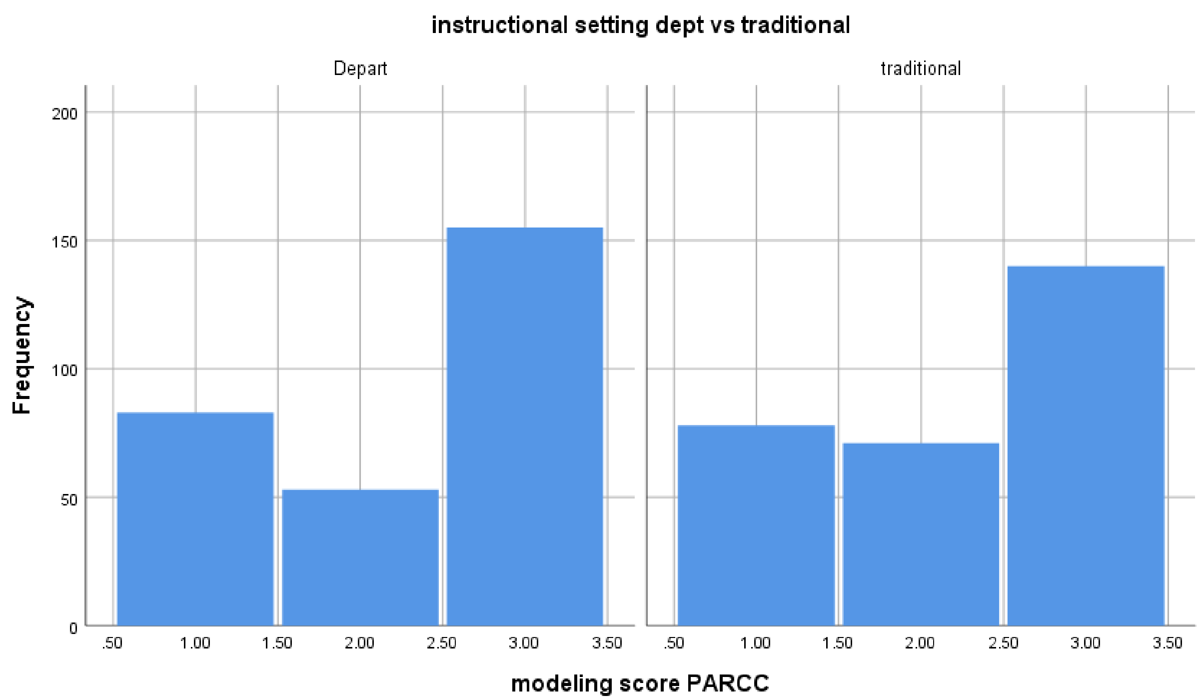

Figure 4. Frequency Distributions for Modeling Scores Based on Setting.

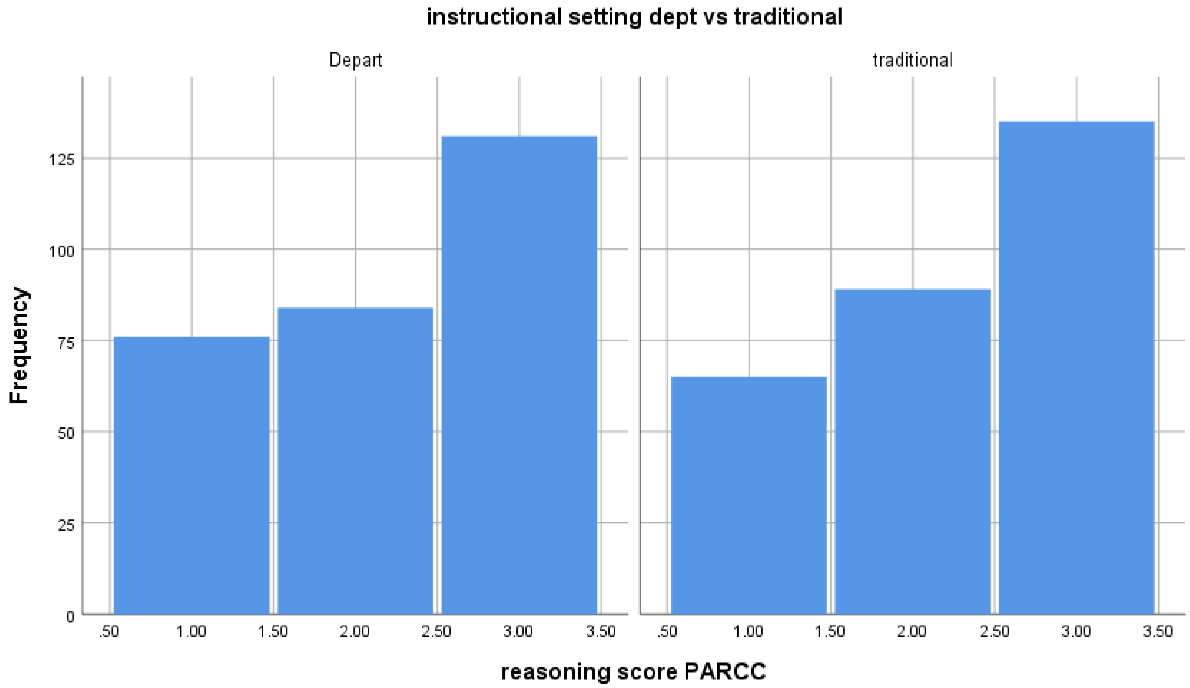

Figure 5. Frequency Distributions for Reasoning Scores Based on Setting.

CHAPTER FIVE: CONCLUSIONS

Overview

The purpose of this causal-comparative, quantitative study was to determine if there was a statistically significant difference in the overall mathematics proficiency, modeling proficiency, and reasoning proficiency scores of economically disadvantaged fourth grade students who received instruction in a departmentalized setting versus economically disadvantaged fourth grade students receiving instruction in a traditional setting as measured by the 2018-2019 PARCC scores. Chapter 5 provides a summary and discussion of the major research findings and implications of the results as they pertain to relevant literature on instructional settings and mathematics learning theory. This chapter concludes with a discussion of the limitations of the study, recommendations for future research, and a brief summary.

Discussion

This chapter contains discussion and future research possibilities regarding the following research question:

RQ1: Does the mathematical proficiency of economically disadvantaged 4th-grade students in a departmentalized instructional setting differ from that of economically disadvantaged 4th-grade students in a traditional instructional setting?

Chapter Two included detailed descriptions of several learning theories related to mathematics development in the early years. Those theories for how students learn mathematics and how educators support their learning are primarily grounded in constructivist learning principles via the works of Piaget and Vygtosky. Both theorists place the role of the educator as facilitator, one identified as a valuable element of student learning and crucial to the development of mathematical knowledge, the application of such knowledge, and mathematical reasoning. Piaget emphasized the importance of mathematics educators in the elementary grades making connections between mathematical concepts and providing various opportunities for students to work with concrete materials while engaging in multiple strategies (Ojose, 2008). Here students develop logic and reasoning in the concrete operational phase; thus, it is essential for educators to understand how students construct information and they must be skilled at activating prior knowledge.

Vygotsky believed the development of mathematical understanding is maximized by the knowledge of the adult who guides the student, one who can properly scaffold student learning within individual zones of proximal development (Vygotsky, 1934/1962). Educators who show skill at carefully choosing activities directly influence the level of proficiency their students reach (Walshaw, 2017). Vygostky also believed the quality of dialogue in the classroom was crucial to student learning (Powell & Kalina, 2009). Thus, the teacher must be skilled at responding to student reasoning and weaving mathematical concepts into instruction and daily activities beyond rote learning (Goos, 2004). Effective instructors of mathematics can probe for justification of thinking and can challenge students to more deeply explore concepts, which can greatly impact student achievement (Firmender et al., 2014).

A review of the literature suggests a departmentalized instructional setting provides an opportunity for the educator to become more skilled at mathematics instruction by providing more time to become an expert in the content area, more time to plan effective lessons, and the opportunity to engage in more focused professional development specific to a content area (Brobst et al., 2017; Gerretson et al., 2008; Reys & Fennel, 2003; Webel et al., 2017). The results of the current study indicated this sample of students, identified as economically disadvantaged, significantly benefitted from receiving instruction in a departmentalized setting, one in which the educator is more likely to become an expert in their content area (Fennel, 2011). This is likely in part due to the expertise of educators serving in the departmentalized setting and their ability to appropriately scaffold instruction when students have gaps in knowledge or skill, which students living in poverty tend to have as they progress through grade levels (Public Impact, 2018). Because of the possible difference in educator instructional strategies used, including the ability to scaffold, and the potential differences in expertise, low-income students in the departmentalized setting outscored their counterparts in the traditional setting by a difference of one performance level indicator.

Children living in poverty have fewer financial resources at home, less cognitive-enrichment opportunities such as books and library visits, and their caregivers tend to be less emotionally responsive (Blair et al., 2008; Kumanyika & Grier, 2006). Many of these students come from single parent homes, a variable in direct correlation with low attendance rates, lower grades, and less of a chance of attending college (Xi & Lal, 2006, as cited in Jensen, 2009). Thus, students living in poverty rely more heavily on the school system for their success than their more affluent counterparts. Reasonably, then, if the educator can expend their energy and focus on one or two content areas, they are better positioned to provide the tailored, targeted support those students need.

The current study aligned with many other research efforts focused on mathematics instruction in a departmentalized setting (Gerberich & Prall, 1931; Gibb & Matala, 1926; Moore, 2008; Patton, 2003; Ponder, 2008; Taylor-Buckner, 2014; Williams, 2009; Yearwood, 2011). Regarding special subgroups, the departmentalized setting is more favorable for some with limited English proficiency, indicating the importance of educator expertise in the discipline when breaking down concepts and scaffolding to meet individual student needs (Ponder, 2008).

Further, when teachers have below-average mathematics backgrounds, students perform better in a departmentalized setting than their peers in a traditional setting (Taylor-Buckner, 2014) This demonstrates how a departmentalized setting may fill gaps in instructor capacity by limiting their instructional focus, thus, improving student outcomes.

However, results for the reasoning and modeling scores in the two groups indicated the instructional setting had no impact on student’s development of mathematical reasoning or their ability to apply mathematics through problem solving. It is possible analyzing of scaled versus raw data prevented the researcher from uncovering true differences. Additionally, it is possible students in this subgroup had more gaps in prior knowledge and efforts to improve modeling and reasoning were hindered by the need to fill in those gaps. This is a reasonable assumption because national data indicate students from low-income families are less likely to be on grade level than their more affluent peers (Public Impact, 2018). Ideally, longitudinal data could provide a clearer picture regarding how modeling and reasoning improves due to repeated exposure to a departmentalized setting. Despite the study results for modeling and reasoning scores, prior research has indicated how the departmentalized setting impacts instructor capacity and one should expect focusing on one content area over time would greatly improve the instructor’s ability to support student reasoning and modeling (Brobst et al., 2017; Chan & Jarman, 2004; Gerretson et al., 2008; Webel et al., 2017).

Consensus in the literature has not been established regarding the most effective instructional setting of upper elementary classrooms. The literature in chapter two indicated self-contained models best support development of the whole child, whereas departmentalized models allow educators to specialize in their content areas, in theory leading to higher academic achievement (Anderson, 1962; Baroody, 2017; Brobst et al., 2017; Chan & Jarman, 2004; Chang et al., 2008; Gerretson et al., 2008; Heathers, 1969; McGrath & Rust, 2002; McPartland, 1987, 1990; Perrachione et al., 2008; Reys & Fennel, 2003; Timms et al., 2007). The impacts of instructional settings on academic achievement are mixed; some studies indicate the departmentalized setting does significantly impact student achievement while others indicate no difference at all (Baroody, 2017; Bastian & Fortner, 2018; Chennis, 2018; Garcia, 2007; Jack, 2014; Kent 2010; Lee et al., 2016; McGrath & Rust, 2002, Koch, 2013; Moore, 2008; Nelson, 2014; Ray, 2017; Williams, 2009; Yearwood, 2011).

Implications for Practice

Prior to this study, there was a major gap in the existing body of literature regarding the impact of instructional settings on the mathematical proficiency of students identified as economically disadvantaged and much of the literature on instructional settings for the general student population provided an unclear picture as to the academic benefits of one setting over the other. This study was designed to not only address the gap but provide additional information regarding how instructional settings may play a role in developing student proficiency. Instructor benefits of departmentalized classrooms have been well-documented in many quantitative and qualitative studies, specifically mentioning reduced workload, more time to plan and prepare, and more time to become an expert in the content area (Brobst et al., 2017; Gerretson et al., 2008; Reys & Fennel, 2003; Webel et al., 2017). These benefits are valuable to the progress of students and subject matter expertise is the cornerstone of student success and achievement (Lederman & Flick, 2003). As a result of this need, many educators have called for more highly qualified teachers in mathematics because many lack the essential mathematical content knowledge necessary for student achievement (Hill et al., 2005; Reys & Fennel, 2003) The need for content expert facilitators in the discipline of mathematics is evident and cannot be ignored.

NCLB, ESEA, and ESSA initiatives have required that states close the achievement gap between subgroups, especially students who come from low-income families. The achievement gap between low-income students and their more affluent peers is double the racial achievement gap between Caucasian and African American children (Porter, 2015). The gaps are even larger for low-income students attending schools with high populations of poverty versus similar students in low-poverty schools (Reardon, 2013; NAEP, 2017). Almost 50 years of testing demonstrates the persistence of this gap between those stricken with poverty and those who are not (Hanushek, Peterson, Tapley, & Woessmann, 2019). Poverty creates many challenges, as parents often have less time to invest in their children's development outside of school. They often work multiple jobs and their families experience high levels of stress, impacting student performance at school. These students rely heavily on their teachers and school systems to fill the gaps and needs they bring to their academic programs. Teachers they engage with everyday have almost three times the impact of any school factor on student performance in reading and mathematics (Rand, 2012). Leadership must use this factor to their advantage and consider placing instructors in settings and content areas that are most advantageous regarding student learning. Utilizing this instructional setting requires no funding and no additional human resources, only creative scheduling and the willingness to try. However, many schools have a limited capacity for change due to the constant reforms and limited attention and energy. Often the level of effort needed to implement departmentalization with fidelity is difficult.

Furthermore, much like the results in the literature, ask ten people who serve in the field of education and one will find they are split on their beliefs of departmentalized classrooms in elementary schools. Although many teachers have reported out the benefits of serving in those settings, many feel student-teacher relationships cannot be sacrificed at the expense of structures only focused on improving academic achievement (Fryer, 2018). Yet, in the face of equity and limiting the vicious cycle of poverty, those serving in the field of education must seek common ground between the two settings, providing the environment for not just the development of teacher subject matter expertise but also supporting the development of strong student-teacher relationships and student character. One plausible solution is utilizing a looping structure, one in which the educator moves up grade levels with their students for two to three years in a row (Barshay, 2018). Research indicates this structure not only leads to higher student achievement but gives the educator a better opportunity to build relationships with their students (Hill & Jones, 2018).

It has been reported that students from low-income families are not only less likely to be on grade level in their core subjects, but less likely to meet the criteria for college success, attendance, or completion (Public Impact, 2018). Mathematics achievement and student-teacher relationships are equally important variables to consider when determining how to close the gap for students living in poverty and ensuring those students have the best chance at success in adulthood. Mathematics achievement has been linked to success in high school, college, and many high paying career fields (Balfanzet al., 2007; Lee, 2012; Rose & Betts, 2001; Shapka et al., 2006). Thus, mathematics understanding, growth, and learning cannot be sacrificed for student-teacher relationships or vice versa, especially for students living in poverty. Moreover, the research on the importance of teacher-student relationships and the impact on student achievement and student engagement has also been well documented (Birch & Ladd, 1997; McGrath & Van Bergen, 2015; Roorda et al., 2011; Valiente et al., 2012). Therefore, if teachers and administration are willing to put in place specialized structures, they must also be willing to work harder to develop relationships with their students to maintain the balance of strong academics and social-emotional learning.

Limitations

Study results were limited by several key factors. First, the sampling procedure created threats to internal validity (Gall et al., 2007). The sample was one of convenience from naturally occurring groups and students could not be randomly selected or randomly placed in the two settings. Although efforts were made to balance each group's case number and other subgroup numbers via a matched sampling procedure, student groups could not be controlled nor could any variables be manipulated due to prior placement by school administrators or teachers. There was also no way for the researcher to determine if students in either setting were transfers from another school within the district. It is possible some student scores in the departmentalized group had originated from students who received instruction in their fourth-grade classrooms in the traditional setting and vice versa.

Second, there were limitations in the data set. The fourth-grade scores analyzed were limited to the students who also had scores from third grade. Although this was done to determine if a covariate was necessary, it limited the number of cases in each group. As mentioned above, not all scores were used due to matching criteria for each group to maintain balance in the number of cases and student subgroups. Although this was done to control for factors such as special education services or limited English proficiency that may have an impact on overall student achievement, it also limited the number of cases and potentially the overall outcome. Also, students identified as low-income are also further labeled as receiving reduced lunches versus free lunches or direct certification due to extreme poverty. Policy changes in 2010 expanded eligibility for the national free and reduced lunch program and opened the door for more students to receive subsidized lunches (Chingos, 2016). As a result of the policy change, however, what was used in the past by researchers to identify students from low income families has now been skewed. It is possible students in the departmentalized setting had fewer students in extreme poverty who received direct certification for free lunches, possibly meaning they had more access to additional resources or supports outside of the school that potentially account for differences in scores. Additionally, the data received for modeling and reasoning were only reported as a 1, 2, or 3. It would have been more beneficial to analyze the raw data scores for modeling and reasoning to determine how different those scores were. Finally, the sample was drawn from only fourth-grade students within a single district, thus the results of the study cannot be generalized to populations outside of the district or other grade levels within the district.

Third, there are many extraneous variables that could potentially be responsible for differences in group means. There were a range confounding teacher variables that could not be controlled which may or may not have had an impact on the results, such as: (a) years of experience, (b) mathematics content knowledge, (c) mathematics content knowledge pedagogy, (d) education level or specialized degrees, (e) mathematics teaching self-efficacy, (f) teaching self-efficacy, (g) student-teacher relationships, or (h) teacher mathematics anxiety. It is also unknown if other school structures, such as tutoring services, interventions, supplemental resources, project-based learning, STEM activities, or behavior initiatives had an impact on student learning. Regardless of the limitations, the information provided in this study adds another piece to the puzzle of instructional settings and the impact on student achievement.

Recommendations for Future Research

Many other areas can be explored further to advance the body of research on the topic of instructional settings in elementary school. Those recommendations are:

1. Consider a study that analyzes differences in specifically how teachers further mathematical reasoning and modeling skills based on instructional setting.
2. Examine growth in instructor capacity based on setting over time, possibly analyzing how the instructor builds student reasoning or supports student problem solving skills.
3. Analyze differences in mathematics teacher self-efficacy in each setting.
4. Analyze differences in teacher content knowledge and content knowledge pedagogy based on instructional setting.
5. Focus primarily on students receiving special education services and how well teachers scaffold instruction based on instructional setting.
6. Examine differences in student growth over the course of multiple years based on instructional settings.
7. Collect data only from Title 1 schools or consider examining data from only students with limited English proficiency.
8. Expand the research to more school districts within a state.
9. Examine differences in student achievement based on setting and only include departmentalized classrooms where the teacher only teaches mathematics.
10. Analyze longitudinal data from elementary to Algebra 1 to determine to what degree the instructional setting in elementary school impacts achievement in high school.
11. Consider a mix-methods study to include the perspective of the educator and students based on instructional setting.

12. Analyze how reading levels impact student modeling and reasoning scores and if a difference exists based on setting.
13. Analyze differences in student scores of those who receive direct certification for free meals based on setting.
14. Analyze differences in student engagement based on setting.

These recommendations may provide a more detailed analysis for educators regarding instructional settings and how they may or may not promote student achievement, student growth, and educator capacity.

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APPENDIX A: ADMINISTRATOR SURVEY

Dear Administrator,

I am a doctoral candidate at Liberty University conducting a research study in your school district to meet final requirements of my Ed.D. degree in educational leadership. I am investigating the impact of departmentalized and traditional instructional settings on 4th graders' overall proficiency in mathematics, mathematical modeling, and reasoning skills. Your response implies consent.

Definitions

- A **departmentalized** model is one in which an educator teaches one or two subjects to multiple groups of students. Students may transition from classrooms for instruction or remain in one classroom with the educator transitioning.
- A **traditional** model is one in which a single educator teaches more than two subjects to one group of students for the entire school year.

Please answer the following questions:

1. School Name (open response)
2. Are you a Title 1 school? (choose yes or no)
3. Did your school utilize a departmentalized instructional setting in your fourth-grade general education classrooms during the 2018-2019 school year? (choose yes or no)

If yes, please answer the following questions. If no, please click the submit button.

1. Did your school utilize a departmentalized or traditional structure in 3rd grade general education classrooms during the 2017-2018 school year? (choose one)
2. Did your 4th grade mathematics educator(s) teach another subject other than mathematics during the 2018-2019 school year? (choose yes or no)
3. If so, what was that subject? (open response)

Thank you,

Elizabeth Medlock, Ed.S.
emedlock@liberty.edu
850-517-7263

APPENDIX B: PARTICIPATION FORM

The Impact of Instructional Settings on Fourth-grade Students' Mathematical Proficiency
Elizabeth C. Medlock, Doctoral Candidate
Liberty University
School of Education

You are invited to be in a research study on the effects of instructional setting on student achievement. You were selected as a possible participant because your school is in xxxxx county and schools within this district serve as the sample for this study. Please read this form and ask any questions you may have before agreeing to be in the study.

Elizabeth Medlock, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to explore differences in mathematical proficiency of fourth-grade students who receive instruction in departmentalized settings versus students who receive instruction in traditional settings. Specifically, I will be examining differences in overall proficiency, reasoning, and modeling scores of 4th grade students by instructional setting using the 2019 overall PARCC score and subclaim scores. A traditional classroom setting is one in which one teacher is responsible for teaching all core subjects to one group of students for an entire school year. A departmentalized setting is one in which a teacher is responsible for teaching in their area of specialization, at most two subjects, to more than one group of students.

Procedures: If you agree to be in this study, I would ask you to do the following things:

1. Answer the brief online survey questions for the purpose of identifying the instructional setting used in your 4th grade classrooms. Information from this survey will be used to code data and form two groups for the study, departmentalized and traditional.

Risks: The risks involved in this study are no more than the participant would encounter in day to day life. There will be no direct contact with students because archival data will be analyzed. Identification of participants will be protected by assigning arbitrary numbers to data and using those numbers in reporting. Student names, student identification numbers, teacher names, principal names, school names, or specific scores will not be disclosed in the report.

Benefits: Participants should not expect to receive a direct benefit from taking part in this study.

Compensation: Participants will not be compensated for participating in this study.

Confidentiality: The records of this study will be kept private. Any sort of report published will not include any identifying information of the students, teachers, principals, or schools included in the study. To maintain confidentiality, an arbitrary number will be assigned to each school that elects to participate in the research study. Research records will be stored securely, and only the researcher will have access to the records. Data will be securely stored on a password locked computer and may be used in future presentations. Only the researcher will have access to the records. After three years, all electronic records will be permanently deleted.

Voluntary Nature of the Study: In compliance with xxxxx County Public School Board of Education policy, your participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Liberty University or xxxxx County Public Schools. If you decide to participate, you are free to not answer any question or withdraw at any time prior to submitting the survey without affecting those relationships.

How to Withdraw from the Study: If you choose to withdraw from the study, please exit the survey and close your internet browser. Your responses will not be recorded or included in the study.

Contacts and Questions: The researcher conducting this study is Elizabeth Medlock. If you have questions later, you are encouraged to contact her at emedlock@liberty.edu, 850-517-7263. You may also contact the researcher's faculty chair, Dr. Nathan Putney, at nputney@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information for your records.

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature of Participant Date

Signature of Investigator Date

APPENDIX C: SCHOOL DISTRICT INTERNAL SURVEY

1. Teacher Name
2. High School Feeder
3. School Name
4. Is there any departmentalization in your school building?
5. If your school does have departmentalization, please specify which grade(s).
6. If your school does have departmentalization, please specify which content area(s).
7. If your school does have departmentalization, please provide a short description of what the departmentalization looks like in your school. Who is responsible for teaching what subjects?

APPENDIX D: SCHOOL DISTRICT APPROVAL

September 18, 2019

Ms. Elizabeth Medlock
[redacted]

Re: Research Application

Dear Ms. Medlock:

Thank you for your interest in conducting **The impact of departmentalized and traditional instruction settings on fourth grade students' math proficiency** in [redacted] Schools. The Research Review Committee reviewed your request.

All requests to conduct research in [redacted]s are reviewed in regard to three major criteria. First, does the research have a potential positive contribution towards improving the delivery of instruction to students attending [redacted] Second, does the research have procedures and processes in place to insure the confidentiality of all participants in the study? Third, does the research obtain its data in such a way that it will have a minimal impact upon the instructional time of students and/or staff?

The proposed study will <u>investigate historical state assessment data and collect data on instructional settings of elementary schools in [redacted]</u>. At this time, your application to conduct research in [redacted] <u>Public Schools is approved with the following conditions</u>:

- Given district access to read-only archival information, you must ensure FERPA protection of confidential student information, using the data at the aggregate level only.
- Deidentify all [redacted]nformation from your research.
- While the Instructional Data Division (IDD) cannot assist with data collection, organization, or analysis, your point of contact will be [redacted] for facilitation and coordination of all school-level communication.

I have also reviewed the study to determine how well it ensures the confidentiality of all respondents. There is nothing that would suggest that personal identifying information will be divulged outside of the research team.

In closing, I would like to ask that you consider this letter as formal approval of your request to conduct your research project in [redacted] Please ensure that all school, teacher, or student identifying information is removed from any prepared documents, either paper or electronic, that may be a part of any final drafts of documents relating to your study. We look forward to the information that our district can gain from your research. As such, please forward a final draft of your completed report to our office.

On behalf of the Research Office, I wish you success in the conduct of your study.

Sincerely,

APPENDIX E: IRB APPROVAL

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

September 20, 2019

Elizabeth Medlock
IRB Application 3968: The Impact of Instructional Settings on Fourth Grade Students' Mathematical Proficiency

Dear Elizabeth Medlock,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study does not classify as human subjects research. This means you may begin your research with the data safeguarding methods mentioned in your IRB application.

Your study does not classify as human subjects research because it will not involve the collection of identifiable, private information.

Please note that this decision only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued non-human subjects research status. You may report these changes by submitting a new application to the IRB and referencing the above IRB Application number.

If you have any questions about this determination or need assistance in identifying whether possible changes to your protocol would change your application's status, please email us at irb@liberty.edu.

Sincerely,

[redacted]

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

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