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Effects of a Computer-Assisted Instruction Program on Mathematics Achievement Growth at Urban Title I Middle Schools

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Effects of a Computer-Assisted Instruction Program on Mathematics Achievement Growth at Urban Title I Middle Schools

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ABSTRACT

Federal reforms such as the Every Student Succeeds Acts (ESSA) and tools such as the College and Career Ready Performance Index (CCRPI) have increased accountability in schools. Two components of the CCRPI are Achievement and Achievement Gap. The accessibility of this data revealed to many stakeholders the underperformance of students from low-income families, Black students, and Hispanic students especially in mathematics. Therefore, initiatives such as the Title I program provide funds through the Georgia Department of Education to schools that have a high number of students from low-income families to assist in meeting student academic achievement standards using effective, evidence-based educational strategies that close the achievement gap. Computer-assisted instruction programs may be used as an intervention to help struggling students.

The purpose of this study was to examine the effectiveness of a computer-assisted instruction mathematics intervention program, Math 180, at improving the mathematics achievement scores of eighth grade students who were enrolled in the program at urban Title I middle schools as measured by the Math Inventory assessment and Georgia Milestones End-Of-Grade assessment using secondary data obtained from the school district.

A multiple regression showed that Math 180 usage predicted students' mathematics proficiency during the 2017-2018 school year which was the first year of implementation in the Stone Hill Public School (SHPS) district, a pseudonym for a district in southeast Georgia. During the next two school years program usage decreased and did not predict students' mathematical proficiency. An independent t-test showed that there was not a significant difference between the pretest and posttest scores of Black or Hispanic students when compared to their counterparts. Even though Math 180 usage only predicted students' mathematical proficiency during the 2017-

2018 school year the findings also showed that according to Student Growth Percentiles (SGP) some students who participated in the Math 180 program achieved at greater rater when compared to academically similar students across the state.

The findings of this study showed that during the 2017-2018 school year, the first year of implementation in the SHPS district, Math 180 usage predict students' mathematics proficiency. However, during the next two school years program usage decreased and did not predict students' mathematical proficiency. The findings also show that the Math 180 program is not more or less beneficial for Black or Hispanic students at increasing mathematics proficiency. Even though Math 180 usage only predict students' mathematical proficiency during the 2017-2018 school year, the findings showed that according to SGP some students who participated in the Math 180 program achieved at greater rater when compared to academically similar students across the state. These findings imply that increased usage increases the impact of the Math 180 program on Math Inventory. Also, that fidelity of implementation could lead to more significant results as it relates to increasing mathematics proficiency in urban Title I middle schools.

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CHAPTER ONE: INTRODUCTION

Background

The National Assessment of Educational Progress' data indicates the achievement of students in urban schools is significantly lower than students in suburban schools (Sirin, 2005). Therefore, there has been more of a focus on increasing the performance of students that attend urban schools, leading to reform efforts to ensure that the educational needs of students at urban schools are being met (Neild & Balfanz, 2006). While schools are often blamed for unequal student outcomes on achievement tests the Coleman Report, published about 50 years ago, states that inequities imposed by family background were more influential than schools on academic achievement (Coleman, 1966). It is important to also consider that students from low-income households make up a large portion of urban public schools. Therefore, differences between students in urban schools and non-urban schools could be attributed to the larger number of students from low-income households enrolled in urban schools (Neild & Balfanz, 2006).

Despite the implication by Coleman that schools have little influence, educational reforms with the main goal of increasing student achievement have been launched. However, those reforms have not taken into consideration the unequal playing field of Blacks students, Hispanic students, and other marginalized groups (Milner, 2012). Educational opportunities amongst students vary; therefore, it is important that instructional practices vary along with students' needs (Milner, 2012). Most students should be able to become proficient in mathematics despite the struggles or difficulties encountered while learning mathematics (Cozad & Riccomini, 2016). To help students reach proficiency, schools and school districts must choose and keep interventions that are shown to move students closer to proficiency by increasing their mathematics achievement (Milner, 2012).

The Every Student Succeeds Act (ESSA) calls for districts and schools to use evidence-based activities, strategies, and interventions to increase the impact of investments. With the limited resources in education, it is imperative that educational activities, strategies, and interventions intended for education improvement are effective (Herman et al., 2017). Computer-assisted instruction is a popular choice as districts look to improve low levels of mathematical proficiency (Barrow et. al, 2009). According to Berrett and Carter (2018) computer-assisted instruction (CAI) "is any type of computer software or technology designed to display instructional material and monitor learning progress in any educational topic." (p. 226). Computer-assisted instruction can offer highly individualized instruction and allow students to work at their own pace which is why it may be more effective than traditional classroom instruction (Barrow et. al, 2009).

The late 20th century brought about many changes in the realm of technology. Examples of this include the increased use of distance learning through online formats and the development of virtual reality platforms (Erhel, 2012). Concurrently new methods were being introduced into the classroom and research revealed that learning was occurring through different mediums, and methods opposed to traditional methods of rote memorization and learning (Ryan, 2012). The benefits of currently trending computer technologies are different for struggling students and higher performing students. Computer-assisted instruction may help students struggling to learn mathematics by not forcing them to keep pace with lectures in a traditional classroom. Computer-assisted instruction enhances the learning of higher achieving students by allowing them to work faster at a pace that is best for them (Barrow et. al, 2009). It is also expected that computer-assisted instruction is more effective for students that have lower attendance rates and may counter the disruptive effects of larger classes (Barrow et. al, 2009). Chronic absenteeism disproportionality affects Black and Hispanic students and is associated with poor academic achievement and urban schools are often classified by large classes (Mireles-Rios et. al, 2020; Roofe, 2018). Hence, computer-assisted instruction could be particularly beneficial to minority students and students in urban schools.

Problem Statement

The problem of this study was that although most students should be able to become proficient in mathematics, many Black and Hispanic students underperform their White counterparts. Specifically, many students in Stone Hill Public Schools district, a pseudonym for a district in southeast Georgia, that is compiled of urban Title I schools, have not demonstrated minimum proficiency in mathematics on Georgia Milestones Assessment System (GMAS) End-of-Grade Assessments (District Annual Report, 2017). This problem is important because student success in the classroom and in the real world is built on a foundation of proficiency in mathematics ((Cozad & Riccomini, 2016). Furthermore, education is proven to play a major role in reducing poverty and enhancing overall living conditions (Bellibas, 2016)

The focus of this study was eighth grade students in urban Title I middle schools in the SHPS district. Understanding that students from varying backgrounds enter school with varying numeracy, academic and cognitive skills (Visser, Juan, & Hannan, 2019) it is important that instructional practices vary along with students' needs (Milner, 2012). Response to Intervention models allow educators to identify and assist struggling students in meeting their individual needs (Lembke, Hampton & Byers, 2012). Knowing when to initiate intervention is also important for educators to improve the achievement of historically underperforming students in mathematics (Johnson & Kritsonis, 2006).

Black students scored almost 24 percentage points lower on National Achievement tests in fourth and eighth grade than their White schoolmates (Georgia Department of Education, 2013; National Center for Education Statistics, 2011). When students do not achieve mastery on grade level standards, future lessons and concepts become harder to comprehend, initiating a snow balling effect in the cycle of failure and decreasing hope for correction (Kober, 2011). The increased skill gap has raised the dropout rate of students in high schools and post-secondary schools and has left many students without the foundational knowledge necessary for abstract advanced mathematical skills (Craig, 2013). Additionally, the lack of corrective action has widened the gap of achievement between Black and Hispanic students and their White peers (National Center for Education Statistics, 2011). With the increased need for remediation in the math classroom, this study examined the use of a computer-assisted instruction program, Math180, and its effectiveness with historically underserved students (Clements, 2012; Fairlie, 2012; Mims-Word, 2012; Sweet, 2012).

Purpose of the Study

The purpose of this study was to examine the effectiveness of a computer-assisted instruction mathematics intervention program, Math 180, at improving student mathematics achievement scores for eighth grade students enrolled in the program at urban Title I middle schools as measured by the Math Inventory assessment and Georgia Milestones End-Of-Grade assessment using secondary data obtained from the Stone Hill Public School district.

To improve student achievement in mathematics SHPS purchased a computer-assisted instruction program, Math 180. Math 180’s scope and sequence was designed by Dr. Sybilla Beckman along with other Common Core architects to help students progress toward their grade level curriculum (Scholastic Inc.,2013). Beckman was a member of the team that wrote Common

Core State Standards. Math 180 focuses on concepts and mathematical practices that will prepare students for algebra, which aligns with the eighth-grade curriculum and the Grade 8 Mathematics EOG (Georgia Department of Education, 2015; Scholastic Inc.,2013). The Grade 8 Mathematics EOG assessment assesses students' mastery of the eighth-grade mathematics curriculum which focuses on functions and linear relationships as a foundation for Algebra and Geometry (Georgia Department of Education, 2014; Georgia Department of Education, 2015). The Georgia Milestones' importance as it relates to accountability as a measure of achievement and its alignment to Math 180 as detailed by the Georgia Department of Education and Scholastic makes it an appropriate measure to examine the effect of the program.

Research from the Scholastic Corporation (2014) indicated that Math 180 produces positive student academic outcomes and pushes students closer to proficiency in mathematics. However, there are not many studies available on the effectiveness of the Math 180 program that were not conducted by the Scholastic Corporation. Also, few previous studies included racially diverse and low-performing students in an urban Title I school district like SHPS. This study was needed because of the gap in research demonstrating the effectiveness of Math 180 at increasing mathematics achievement for students underperforming in mathematics in a district like SHPS. The results from this study may provide valuable evidence on the success of the Math 180 program in SHPS.

Research Questions

The research questions for this study are:

1. To what extent is the computer-assisted instruction program effective for improving mathematical proficiency in Title I urban school?
2. To what extent is the computer-assisted instruction program effective for improving

mathematics performance in Title I urban schools by ethnicity?

3. How often do Math 180 students experience low growth, typical growth and high growth on the Georgia Milestones End-of-Grade assessment based on student growth percentiles?

Definitions

Achievement Gap. The systematic variances in academic performance measures between different groups of students (McFeeters, 2019)

Computer-Assisted Instruction. The use of computer technology to assist in the delivery of instruction (Hamilton, 2019)

Math 180. Math 180 is an intervention program for students struggling in mathematics from 5th - 12th grade (Scholastic Corporation, 2014).

Adaptive Test. Adaptive tests automatically adjust item presentation based on the examinee's estimated instructional level or accuracy on previous items (Clemens et al., 2015).

Disadvantaged Students. Students that encounter financial, family, or social obstacles that hinder their ability to learn at schools (What is a "disadvantaged student?", 2021)

Significance of the Study

The significance of this study was that it will contribute to the literature related to understanding the relationship between computer intervention programs and student achievement scores specifically at urban Title I middle schools. Due to low levels of mathematical proficiency policy makers, parents and schools are looking for effective ways to improve students' math skills and computer technology is commonly a solution (Barrow et. al, 2009). The results of this study are important because they may provide valuable information to mathematics educators, parents, policy makers and stakeholders about the effectiveness of Math 180 at increasing student achievement in urban Title I schools. School districts could also use the results of the study to determine if the impact Math 180 has on student achievement is worth the funds allocated to implement the program.

SHPS began using the Math 180 program as an intervention for students struggling in mathematics in 2017. After four years of implementation this study may be significant in providing useful data about the effectiveness of the program at increasing student achievement in the district. Research data may help district leaders make informed decisions on retaining or relinquishing the program.

Organization of the Study

This study consists of five chapters. Chapter 1 has provided an overview of the study with the following sections: background, problem statement, purpose of the study, research questions, definitions, and significance of the study. Chapter 1 will also provide the theoretical framework. Chapter 2 will review and analyze research on the achievement gap, challenges in urban schools, Title I funding, computer-assisted instruction, previous research on computer-based instruction, academic growth, and academic achievement. Chapter 3 will present the methodology for the study and will include the following sections: introduction, research questions, the research design, setting, participants, Math 180 implementation, measurement, validity and reliability, data collection, data analysis and procedures, limitations and assumptions, ethical considerations, and summary. Chapter 4 will present the results of the analysis. Chapter 5 will present a discussion of the results of the study.

Theoretical Framework

The theoretical framework of this study consists of two theories, Critical Race Theory and Constructivism Theory. Critical Race Theory along with the concept of intersectionality were used as a theoretical framework for this study to promote understanding of the challenges students in urban Title I schools face. Critical Race Theory is discussed first then intersectionality because intersectionality plays an important role in how Critical Race Theory scholars explore how racial inequalities are impacted by various aspects of identity and social structure (Corus et. al, 2016; Gillborn, 2015). Constructivism will also be used a theoretical framework because it promotes the notion that "the learner's basis of meaning is found in his or her direct experience with a dynamic and responsive world," and that "we can only form concepts through our bodily actions" (Davis et al., 2000, p. 65). The historical roots of constructivism belong to Piaget's understanding of knowledge formation.

Using Critical Race Theory and Constructivism as a lens will help frame my understanding of urban school challenges by focusing on the dynamic structures of race to develop a better understanding of inequalities in education while also focusing on how knowledge is formed.

Critical Race Theory

Critical Race Theory began in the 1970s as a response to attacks on the achievements of the civil rights struggle (Simba, 2019) with roots in critical legal theory and radical feminism (Delgado, 2001). The response was led by legal scholars Derrick Bell, Mari Matsuda, Charles Lawrence, Kimberlé Crenshaw, and Alan David Freeman (Simba, 2019). According to Snipes and Walters (2005) scholars believed Critical Race Theory could also be used to examine the educational system. In education, Critical Race Theory brings attention to the multifacetedness of society, institutions, schools, and classrooms (Zamudio, 2010). It also portrays racial inequality in education in its entirety (Zamudio, 2010). Critical Race Theory acknowledges that race and racism can play a role in educational opportunity, experiences, and outcomes (Howard & Navarro, 2016) by challenging mainstream education policies and practices (Zamudio, 2010)

Using Critical Race Theory as a lens will help frame the researcher's understanding of urban school challenges by focusing on the dynamic structures of race to develop a better understanding of inequalities in education (Zamudio, 2010). Using this theory as a framework will also provide a basis for critical action towards transformations in education so that students' needs can be better served. Critical Race Theory focused this study on how decisions made in schools promote success for some students and failure for others (Zamudio, 2010). According to Ladson-Billings (1998), "...CRT can be a powerful explanatory tool for the sustained inequity that people of color experience (p. 18)." In examining the role race and racism can play in educational opportunity, experiences, and outcomes it was important that I use Critical Race Theory to help shape my understanding and substantiate the need for this study.

The term intersectionality was first used in 1989 by Kimberlé Williams Crenshaw, the originator of the concept (Garcia, 2019; Carastathis, 2016). It began as a way to theorize the connectedness of race and gender (Carastathis, 2016) in Crenshaw's essay titled "Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics" in response to feminist and racism studies centered around White women and Black men, respectively (Garcia, 2019). Over the last three decades intersectionality has expanded to not only theorize the connectedness of race and gender, but it is also now widely used in contemporary social science to address how multiple forms of inequality and identity connect (Gillborn, 2015).

When studying social inequalities and life experiences intersectionality is one of the most important concepts within the social sciences (Garcia, 2019). Intersectionality treats markers such as race, ethnicity, social class, and religion as interconnected variables that shape an individual's life experiences and circumstances (Garcia, 2019). Gopaldas and Fischer (2012) define intersectionality as a social identity space consisting of one or more social identity categories that are connected. Intersectionality places individuals in their own social identity space in which it is understood that individuals that share markers still experience life differently (Corus et. al, 2016). Prior to intersectionality social science researchers treated these markers as isolated variables not considering how they intersect (Garcia, 2019). Considering race, identity and social class as isolated variables provides a limited understanding of complex and intricate life experiences (Garcia, 2019).

Intersectionality allows for increased understanding of social inequities and how social inequities are created and supported (Gillborn, 2015). By analyzing structural intersectionality, the needs of some of the most vulnerable individuals can be addressed (Corus et. al, 2016). Intersectionality is important in shaping my understanding of urban school challenges because the experiences of historically disadvantaged students that are underperforming may be viewed individually even though most of the students belong to two or more identifying categories (Corus et. al, 2016).

Constructivism

Jean Piaget is the main pioneer of constructivism and is credited with its development. Constructivism focuses on a learner’s ability to mentally construct meaning of their own environment and to create their own learning (Quay, 2003). Knowledge from a constructivist perspective is viable and adaptive. Piaget states that for new knowledge to be constructed cognitive conflict is essential (Kretchmar, 2019). Cognitive conflict is caused by disequilibrium and the need to maintain equilibrium which according to Piaget drives all learning (Kretchmar, 2019). Therefore, cognitive conflict is essential for new knowledge construction. New experiences or information can fit into existing mental structures through assimilation which is mostly an unconscious process. However, when knowledge or experiences contradict prior knowledge or experiences the learner must accommodate what is known. From the constructivist perspective learning only occurs through this process of accommodation (Kretchmar, 2019).

As a teaching practice, Constructivism is associated with different degrees of non-directed learning. Constructivists believe that all humans can construct knowledge in their own minds through a process of discovery and problem solving. During this process students use background knowledge as well as skills learned from the teacher to discover new information (Tam, 2000). This process aligns with Math 180's instructional model that includes the rotation of two groups. During the approximately 25-minute group instructional session the teacher focuses on building understanding, reasoning, and communication skills. During the approximately 25-minute personalized software session students receive additional instruction and scaffolded practice with routine and non-routine problems using the Math 180 adaptive software program which promotes problem solving and discovery learning(Scholastic Corporation, 2014).

Piaget and other constructivists emphasize that learning is an active process. Meaning that by reflecting, analyzing, questioning, and working on problems learners develop their structures of knowledge. Piaget also emphasizes how important prior knowledge is in the learning process. Constructivists recognize that prior knowledge is the foundation that new knowledge is built. With these ideas a constructivist classroom is learner centered (Kretchmar, 2019). The idea of a learner centered classroom also aligns with Math 180 which promotes student agency by giving students access to their recent achievements and instructional zones. By continuously collecting data and sharing that data with the students, students have the ability to witness their progress which gives them a voice in their own learning (Scholastic Corporation, 2014). Constructivism infers that students should be more responsible in the learning process and that they learn through interactions between their experiences and ideas (Tam, 2000).

Social constructivism as outlined by Lev Vygtosky compliments Piaget's cognitive constructivism therefore many believe that learning is a cognitive and social process. Social constructivism focuses more on how culture, language, and social interaction aid in knowledge construction. Vygotsky differentiates between the construction of spontaneous concepts which are developed during everyday activities and the construction of scientific concepts which are developed during more formal settings such as the classroom (Kretchmar, 2019).

With computer-assisted instruction, students receive individualized instruction and rewards that assist in motivating the learner to achieve more. Tam (2000) related constructivism to the construction of technology-supported learning environments. The author explored how constructivism theory and education technology combined to transform learning through technology from a highly industrialized mass production model to one that emphasizes the subjective construction of knowledge and meaning derived from individual experiences (Tam. 2000). In the constructivism framework, classrooms provide learners with the opportunity to observe, work, explore, interact, and raise questions which aligns with Math 180 in the ways described. This learner centered approach allows learners to uniquely construct knowledge based on their experiences through active participation. This contradicts behaviorism in which the learner is considered a subject opposed to an active participant (Singh & Yaduvanshi, 2015).

CHAPTER TWO: REVIEW OF LITERATURE

Overview

This chapter contains an in-depth review of the literature, which investigates the achievement gap, challenges in urban schools, federal policy to improve student outcomes, computer-assisted instruction, academic growth, and academic achievement. Literature related to technology-based mathematics remediation was also reviewed to establish information and previous research available on the impact of technology-based remediation and the impact on test scores is included.

Achievement Gap in Education

It is not uncommon to hear discussions of the achievement gap amongst educators, especially educators who are looking for solutions to the ongoing disparities in measures of educational performance between groups of students in the United States. Rojas-LeBouef and Slate (2012) defined the achievement gap as the difference between how well students from low-income families and children of color perform on standardized tests when compared with their middle to upper-class peers from dominant cultures. However, Weither and Tedin (2006) stated that the achievement gap reveals itself in multiple areas such as Black and Hispanic students achieving at lower levels than White students of the same age, the graduation rate for Black and Hispanic students is lower than that of White students, Black and Hispanic students are less likely to attend postsecondary institutions, are less likely to obtain an advanced degree and Black and Hispanic students consistently perform lower than White students on achievement tests. Meaning independent of what is being measured Black and Hispanic students underperform when compared to White students (Weither & Tedin, 2006). There has been progress but since society values rank more than individual achievement the gap in outcomes is important (Weither & Tedin, 2006).

The achievement gap shows that our education system is failing to educate all students equally. According to Bromberg, Theokas & Education (2013) the United States of America has prided itself “on being a land of opportunity where all children can excel, but we’ve only delivered excellence to some” (p. 2). Achievement gaps between low-income and higher-income groups and Black and/or Hispanic students and White students are measured as the differences between average scores or as the differences between proficiency rates (Bromberg & Theokas, 2013; Rojas-LeBouef & Slate, 2012). “For many years, low-income and minority children have been falling behind their white peers in terms of academic achievement” (Rojas-LeBouef & Slate, 2012, p.7), some may say that this data makes sense because Black and Hispanic students and students from low-income families are not as intellectually capable as their counterparts. However, it may be stereotypes like this one that perpetuate underachievement of Black and Hispanic students and students from low-income families. The achievement gap is a well-known problem in education and there is literature and research that attributes the gap in achievement to the challenges many low-income and minority students face in and out of school. These challenges are referred to as an opportunity gap which shifts the thinking from outcomes to inputs. The opportunity gap that exists between racial and related lines refers to the crucial resources and opportunities children of color are denied making their attainment of educational and life success less likely (Prudence, et. al, 2013). Namely, students that attend urban schools will have different life experiences when compared to students that attend rural schools (Phillips, 2019).

Challenges in Urban Schools

Although there is not a common definition of what constitutes an urban school amongst educational researchers, practitioners, and policy makers (Walsh & Swain, 2020) urban is often defined as being a characteristic of or representing a city. This definition aligns with the word's Latin origin from "rubs urbis", which means city (Fisher, 2015). By definition and origin, urban describes a place, not race or socioeconomic status. Therefore, it is critical to note that the race or socioeconomic status of the students at a particular school is not what classifies the school as urban, instead a school's location and population density classify it as urban. Despite the classification process not involving race or socioeconomic status, urban schools consist of predominantly Black, Hispanic, and impoverished students (Lewis & Moore, 2008).

More recently the word "urban" has been socially constructed to be a characteristic of people. Using intersectionality theory, Fisher (2015) argued that the term "urban" has become an intersection of three constructs: race, socioeconomic status, and social capital. Examining these social constructs further: race is a cultural grouping or a biological entity, socioeconomic status is a combination of family income, parental education and occupational status and social capital is the benefit of belonging to a particular network of individuals. Intersectionality is a dynamic and powerful theory that helps us better understand constantly evolving social constructs (Fisher, 2015). Fisher (2015) elaborated by stating that this is evident in the way that these three constructs come together and in one word become a tainted label.

For students that attend urban schools a high-quality education seems unattainable (Lewis & Moore, 2008) as they are depicted as having low academic achievement, widespread course failure and high dropout rates (Nield & Balfanz, 2006; Lewis & Moore, 2008). These unequal student outcomes pose another question, "Why are student outcomes unequal?" Unequal outcomes could be due to the experiences of many Black and Hispanic students in and out of school. The economic circumstances many Black and Hispanic students experience as they grow up often brings about reduced educational achievement (Weither & Tedin, 2006).

There are in-school and out-of-school factors that may contribute to the gap in mathematics achievement between Black and Hispanic students and their counterparts (Balfanz & Byrnes, 2006). Some contributing factors may be that parents of Black and Hispanic students often have less education, and their homes lack resources such as reading material, computers and games that accelerate learning. Also, that the culture of schools is not familiar or comfortable to many Black and Hispanic students which may impact educational achievement (Weither & Tedin, 2006). These and more out-of-school factors may lead to unequal outcomes, one of the outcomes being reduced educational achievement which eventually transfers to obstacles for their future children creating a seemingly unsolvable generational problem that Weither and Tedin (2006) refer to as a Gordian knot.

Possible in-school factors are a weak and unfocused curriculum, shortage of qualified mathematics teachers, less exposure to a rigorous curriculum, students that are not as motivated as they should be and teacher-student relationships that are lacking (Balfanz & Byrnes, 2006; McKown, 2013). There is research that supports that the converse of these in-school factors benefit White students and that they directly influence the achievement gap (McKown, 2013).

Students that attend urban schools may face a variety of challenges (Lewis & Moore, 2008), but the following sections provide an overview of the six challenges that were identified by the literature as being significant influencers of student outcomes. The six challenges are poverty, financial support of schools, teacher shortages, infrastructures, increased behavior problems and increased linguistic diversity.

Children who attend urban schools are more likely to live in poverty (Dolph, 2017). In 2019 the U.S. Department of Health and Human Services indicated that the poverty guideline was $25,750 for a family of four which was $43,058 less than the living wage (Nadeau, 2020). This statistic supports that students living in poverty are at an extreme economic disadvantage (Dolph; 2017; Hudley, 2013; Kincheloe, 2010). Urban students living in poverty sometimes receive insufficient prenatal care, have poor diets, have less intellectual stimulation, and have less access to regular and adequate health care when compared to students who live in more affluent rural and suburban areas (Dolph, 2017). These factors contribute to making learning challenging for students who attend urban schools because it is difficult for students to focus on learning when they are worried about eating, stability, or other issues common to families living in poverty (Dolph, 2017).

A large portion of financial support for schools comes from property value or resident income making inadequate funding a second challenge for urban schools (Dolph 2017; Kincheloe, 2010). Low property values and lower resident income in urban areas means less funding. As a result, urban schools tend to have fewer or outdated resources such as textbooks, technology and instructional equipment when compared to schools in more affluent and/or suburban areas. These conditions make urban schools more often places of developmental risk instead of places conducive to positive developmental outcomes (Hudley, 2013).

The teacher shortage in many urban schools especially the shortage of certified, or qualified mathematics, science, and special education teachers can be the cause of unequal outcomes (Dolph, 2017; Hudley 2013; Kincheloe, 2010). Staffing high-poverty schools with highly qualified teachers is difficult (Jacob, 2007). Therefore, it is more common for teachers in urban schools to be less than highly qualified when experience, educational background, and teaching certification are considered and compared to teachers at low-poverty schools (Hudley, 2013; Jacob, 2007). The teacher shortage at urban schools is a result of teachers receiving lower wages and facing more difficult working conditions when compared to teachers at suburban or rural schools (Dolph, 2017).

A shortage of teachers, especially qualified teachers in critical subject areas may mean that students are not receiving quality instruction (Dolph, 2017). To ensure that students are receiving quality instruction urban schools need qualified teachers to improve student learning and performance (Urban Teacher Collaborative, 2000). Peske et. al (2006) reiterates this idea for marginalized students stating that "…public education cannot fulfill its mission if students growing up in poverty, students of color and low-performing students continue to be disproportionately taught by inexperienced, under-qualified teachers" (p. 15).

The infrastructures at urban schools can also play a role in affecting student outcomes. The infrastructures are often old, run down and in need of repair. These conditions present air quality issues, acoustic issues, poor lighting, roofs that leak and subpar heating and cooling systems. Other issues involve security systems, fire safety and communication systems (Dolph, 2017). These structural conditions and potential health and safety issues negatively impact students' ability to focus on learning (Dolph, 2017; Hudley, 2013). These types of negative learning environments for both students and teachers present a challenge for educating students that attend urban schools (Dolph, 2017).

Urban schools also tend to be faced with more student behavior problems and require more discipline by teachers when compared to suburban and low poverty schools (Lippmann et al., 1996). The behavior problems include student absenteeism, fighting, disruptive behavior, drug possession and weapon possession (Dolph, 2017; Lippmann et al., 1996). This challenge of dealing with more behavior problems and disciplinary issues, places additional stress on teachers and takes the focus away from ensuring quality learning. However, addressing behavior problems is essential to ensuring a safe learning environment (Dolph, 2017).

Another contributing factor to unequal outcomes is the increased amount of linguistic diversity that can be found at urban schools (Dolph, 2017; Kincheloe, 2010; Lippmann et al., 1996). According to the Urban Teacher Collaborative (2000) “urban schools nationwide educate between 40% and 50% of the students who are not proficient in English” (p. 6), which makes communication more difficult and learning more complicated (Dolph, 2017). Staffing qualified educators to support students with limited English proficiency is not easy (Dolph, 2017), which makes effectively teaching students with limited language proficiency challenging.

These are just a few of the challenges students and teachers in urban schools encounter that are far less common in suburban, rural, and low poverty schools that may serve as contributing factors to unequal outcomes. It is important for educators and researchers to consider these challenges, the experiences and the backgrounds of urban students that can impact their ability to achieve academically, attain an education and eventually be successful in the labor market (Dolph, 2017; Lippmann et al., 1996).

Federal Policy to Improve Student Outcomes

The U.S. Elementary and Secondary Education Act (ESEA) was a turning point in federal policy in 1965 (Cascio & Reber, 2013). ESEA was created as a part of the “War on Poverty" by President Lyndon B. Johnson (Rosa & Lake, 2015) which included a Title I provision to increase federal revenues for K-12 education to support children from low-income families. Title I is a federally mandated program administered by the federal government to provide funds to local education agencies (LEA) for individuals who are economically disadvantage. Under Title I of

ESEA President Johnson's administration began providing funding specifically for the educational minority and economically disadvantaged. Title I funds are distributed to LEA then LEA distribute the funds to schools with the most students from low-income households (Phillips, 2019). Title I funds are intended to be used to benefit students by giving them an opportunity to succeed academically and by aiding schools as they strategize to improve instruction (Ysseldyke et. al, 2004). Schools with less than 40 percent of students identified as coming from a low-income family must focus funds provided from the Title I program on students who are most at jeopardy of not demonstrating proficiency on the academic curriculum. However, schools with more than 40 percent of students identified as coming from low-income households can use funds schoolwide for all students (Phillips, 2019).

According to former U.S. Senator Kennedy (Successful implementation of Title I, 2003), Title I legislature symbolizes America's commitment to the American dream by providing equal opportunities to all Americans. The goal of Title I is to close the achievement gap between students from different economic backgrounds by providing resources to schools that serve disadvantaged students to ensure that those students have the opportunity to receive an equal education, by making sure all students have equal access to the educational resources and the skills they need to achieve proficiency (Phillips, 2019; Ysseldyke et. al, 2004). By narrowing the achievement gap the Title I program aims to "break the cycle of poverty". According to the US Department of Education the purpose of the Title I program can be achieved by holding state and local educational systems accountable. This can be done by having measurable outcomes, meeting the needs of children, and allowing schools with the greatest needs to use resources to improve educational services school wide (Phillips, 2019). The focus of the program was widened from just remedial services to school-wide reform when ESEA was revised in 1994.

The revision was supported by research that found that students in low-income schools were negatively impacted by the conditions of poverty not just students from low-income households (Phillips, 2019).

Title I was reauthorized in 2002 as the largest program of the No Child Left Behind Act (Cascio & Reber, 2013). No Child Left Behind (NCLB) was a revision of ESEA, signed into law by President George W. Bush. NCLB operated under the principle that every child can learn, is expected to learn, and must demonstrate learning (Baskin, 2019).

More recently in 2015 ESEA was reauthorized in The Every Student Succeeds Act (ESSA) by President Barack Obama (Baskin, 2019). ESSA replaced NCLB, which did not directly address the opportunity gap or inequity of resources that perpetuate the achievement gap (Cook-Harvey et. al, 2016). ESSA differs because it places greater attention on equity and excellence by focusing on the achievement and opportunity gaps among students within and between schools and districts, especially students who have been historically underserved in terms of educational achievement (Cook-Harvey et. al, 2016). ESSA supports the initial aims of Title I that Kennedy discussed by setting expectations for states to design standards and assessments. ESSA requires states to use multiple measures to evaluate student and school progress, address resource gaps between schools and support the use of evidence-based interventions (Cook-Harvey et. al, 2016).

By placing more of the policy-making power at the state level, state educational agencies were able to develop individualized ESSA plans and accountability systems (Chu, 2019). Accountability systems under ESSA do not focus solely on standardized tests as they did previously (Chu, 2019) but include indicators that can determine and increase students' opportunity to learn (Cook-Harvey et. al, 2016). These additional indicators encourage schools and stakeholders to pay attention to curriculum access, access to well-qualified teachers and access to resources that influence student learning outcomes (Cook-Harvey et. al, 2016) with the goal of promoting equity (Chu, 2019). ESSA's indicators require ensuring that accountability systems developed by each state "are based on research about factors associated with stronger achievement and graduation, and districts have found that attending to them has improved outcomes" (Cook-Harvey et. al, 2016, p. 10).

The goal of the reforms such as ESEA, NCLB and ESSA are to ensure that all children receive a good education. It is important that all students receive a good education because education opens the gate for future opportunities (Templeton, 2011). Education has the power to open the gates of opportunity by reducing poverty because educated people are more likely to get jobs; they are more productive and earn more money (Van den Berg, 2008). Van de Berg (2008) also stated that one of the social benefits of education is increased healthcare of children. The results of obtaining an equal and equitable education support the claim of Horace Mann and later John Dewey that "education is the great equalizer" (Goyette, 2017). From the literature it becomes evident that some of the contributing factors to unequal educational outcomes are the inequalities and inequities that minority students and students from low-income households' experience in school. It also becomes evident that income inequality can lead to unequal educational outcomes and unequal educational outcomes can lead to income inequality, creating a cycle.

Despite attempts of urban school reform through changing federal policy, issues of inequity based on race, ethnicity, socioeconomic status, and other defining characteristics remain in the United States and its education systems (Chu, 2019). Disparities in educational opportunities and outcomes between more privileged students and students from marginalized groups remain as well (Chu, 2019). The disparities have led educators to look to technology for assistance.

Equity Through Computer-Assisted Instruction

Computer technology is often proposed as an option to improve educational opportunities and outcomes especially low levels of mathematical proficiency (Barrow et. al, 2009). In schools with a high percentage of students from low-income households Title I funds are used to support school-wide initiatives to improve student outcomes and lessen the gap in student achievement (Phillips, 2019).

Computer-assisted instruction (CAI) has become a popular education technology as the internet and computer become increasingly popular over the last few decades. The first country to study computer-assisted instruction was the United States in 1958. It was not until the 1990s that CAI caught the interest of the majority (Guo, 2018). At that time universities and companies started working on the development and generalization of computer-assisted instruction software and saw that CAI could meet the needs of the education field (Guo, 2018). Computer-assisted Instruction involves using computers to assist in providing instruction. The software CAI uses presents learners with information and guides the learner through instructional goals and checks their progress along the way. It is important to distinguish CAI from Computer-Based Instruction (CBI) even though there is some overlap. Unlike CAI, CBI also refers to instruction that can fully replace the teacher (Hamilton, 2019).

CAI has been found to make learning more engaging by shifting learning from being teacher centered to student centered. CAI enhances learning by being an interactive process that helps learners reach designated instructional goals and improve education outcomes (Usman & Madudili, 2020). CAI is characterized by learner-controlled instruction, prompt feedback, selfpacing, and adaptability (Usman & Madudili, 2020). Features of CAI include personalizing information to increase students' interest in the tasks and providing an organized sequence of materials (Sharma, 2017). There are several features of CAI that have been shown to increase student learning. CAI increases student learning by providing creative context and by providing practice activities that are challenging to students and stimulate their curiosity. Creative context increases student learning by allowing learners to make their own choices about their learning which increases students' motivation (Sharma, 2017).

CAI also provides students with "locus of control" which means that students have more control over their learning experience and the pace at which they learn (Hamilton, 2019). Students can also be confident in their progress because CAI offers frequent and often immediate feedback increasing their locus of control. Locus of control is a concept that refers to how much control individuals believe they have over what happens to them (Keenan, 2020). Some individuals have more of an internal locus of control and other have more of an external locus of control. An individual with an internal locus of control believes that what happens is a result of their own abilities, efforts, and actions. An individual with an external locus of control believes that what happens is outside of their control. It has been found that individuals with more of an internal locus of control are more likely to do well academically (Keenan, 2020).

By allowing students to progress through instructional goals at their own pace CAI prevents students from getting bored or lost because a teacher is moving too slow or too fast, respectively (Hamilton, 2019). CAI allows for students to stay on a learning objective if they need to develop mastery before moving to the next objective. Students who master a concept at a faster pace benefit as well because they can move to the next concept sooner (Hamilton, 2019).

Customized instruction like this allows for more complete learning and is referred to as Mastery Learning (Ungvarsky, 2020).

Technology supports students' mastery of concepts at each level by allowing students to repeat activities until they understand (Saveg-Sanchez & Rodriguez, 2020). Benjamin S. Bloom created the concept of Mastery Learning four years after he developed Bloom's Taxonomy. This was during the same time that efforts were being made to eliminate inequities in education and many other areas (Ungvarsky, 2020). Bloom proposed that the traditional classroom in which teachers lectured, provided students with an opportunity to practice then assessed prior to moving to the next concept contributed to differences in academic achievement. To help students achieve better results Bloom suggested a more individualized approached, which he named mastery learning (Ungvarsky, 2020). John B. Carroll also believed that all students are capable of learning, some just need more time than others. He is considered a contributor to the concept of mastery learning (Ungvarsky, 2020).

Mastery Learning is a subcategory of Adaptive Learning which is a trend that allows teachers' students to learn at their own pace and provides differentiation (Saveg-Sanchez & Rodriguez, 2020). Mastery Learning operates under the belief that all students can achieve the classroom learning objectives while understanding that some students require more time than others (Ungvarsky, 2020; Saveg-Sanchez & Rodriguez, 2020). The mastery learning environment consist of adequate feedback as students work on a topic until they can demonstrate mastery (Ungvarsky, 2020; Saveg-Sanchez & Rodriguez, 2020).

Mastery Learning has been found to contribute to positive changes in students' attitudes toward learning, even more so on low performing students. There is also research that found

Mastery Learning to have negative impacts on learning quality by reducing the number of topics covered in a course (Saveg-Sanchez & Rodriguez, 2020).

A major component of mastery learning is providing students with a pre-assessment before teaching a concept so that teaching can be individualized based on students' needs. Throughout the learning process students are provided with frequent feedback and keep working until they achieve at least 80 percent mastery. Mastery learning provides students that require more time to achieve mastery with the additional time they need and provides students who learn a concept more quickly the ability to move at a faster pace(Ungvarsky, 2020).

Studies have shown that mastery learning is a beneficial approach to learning that does not allow students to give up on learning concepts. This is important because learning is cumulative and mastery learning ensures that students master each concept prior to moving to the next concept. The mastery learning approach also thwarts teachers from teaching at the pace of students that learn the fastest and leaving students that need more time behind (Ungvarsky, 2020). These advantages of CAI are not generally available or realistic with traditional instruction.

CAI also has several limitations. One of those limitations is the cost of CAI programs (Sharma, 2017). According to Hamilton (2019) two major issues of concern for public school policymakers that relate to cost are: the cost of the hardware and software and the cost of training teachers. As with most technology, CAI programs may become outdated which would make the resources devoted to the program a waste. Getting teacher buy in may also be a challenge. Teachers may fear new technology, may not want to devote extra time into learning to use the program and may see it as a threat to their job (Sharma, 2017).

Previous Research on Computer-Based Learning

The Every Student Succeeds Act (ESSA) calls for districts and schools to use evidenced based activities, strategies, and interventions to increase the impact of investments. With the limited resources in education, it is important that educational activities, strategies, and interventions intended for education improvement are effective (Herman et al., 2017). Computer-assisted instruction (CAI) is a popular choice as districts seek to improve low levels of mathematical proficiency (Barrow et. al, 2009). According to Berrett and Carter (2018) CAI "is any type of computer software or technology designed to display instructional material and monitor learning progress in any educational topic" (2018, p. 226). CAI can offer highly individualized instruction and allow students to work at their own pace which is why it may be more effective than traditional classroom instruction (Barrow et. al, 2009).

Math 180 is an intervention program designed to help students struggling with early mathematics achievement and motivate students to learn the content that is important for them to succeed in algebra (Scholastic Inc, 2013). According to Hutchinson (1999) the difficult but important questions are "what works, in what context, with which groups, and at what cost?" This study aims to answer three of those four questions by examining the program's effectiveness at increasing mathematics achievement in a district where Black and Hispanic students make up 89% of enrollment and all schools are classified as Title I.

There is a body of literature that discusses the effect of computer-based learning on students' mathematics achievement on state standardized tests and computer adaptive achievement assessments such as the NWEA Measures of Academic Progress and the Houghton Mifflin Harcourt Math Inventory (Scholastic Inc, 2013). However, there is a limited body of research that discusses the effect of computer-based mathematics programs specifically on Black students', Hispanic students', and students from low-income families' achievement.

Shcneyderman (2001) conducted a quasi-experimental study that evaluated the Cognitive Tutor Algebra I Program to explore students, instructional outcomes and attitudes towards mathematics and teachers' opinions about the program. The study consisted of 658 participants from six high schools. Students in the intervention group were taught using Cognitive Tutor Algebra 1 for a full school year. Students in the comparison group received Algebra 1 instruction using a curriculum not identified by the author. The research questions were 1) Does the program increase academic achievement, 2) Does the program improve students' attitudes toward mathematics, and 3) What are the teachers' views on the effectiveness of the program? The outcome measure for mathematics achievement was the Florida Comprehensive Test-Norm Referenced Test (FCAT-NRT). The results of the comparison of the mathematics scores indicated that the mean scale scores of students in the intervention and control group did not differ significantly. A modified version of the Fennema-Sherman Scale was used to measure students' attitudes towards mathematics. The results showed that students in the intervention group had significantly higher confidence about learning mathematics than the control group. A teacher questionnaire was used to assess teachers' reactions to the Cognitive Tutor Algebra 1 Program. The responses indicated that all teachers believed that the program had an overall positive effect on student learning.

Wijekumar (2009) conducted a randomized controlled trial to obtain estimates of the effect of Odyssey Math on the mathematics achievement of grade 4 students in 32 elementary, intermediated and charter schools. The study consisted of 2,456 participants who were randomly assigned to intervention or control groups using the same mathematics curriculum. Odyssey

Math was used for an average of 38 minutes each week as a partial substitute for the regular mathematics curriculum although teachers were advised to use it for 60 minutes each week. The confirmatory question the study sought to answer was, do grade 4 classrooms using Odyssey Math as a partial substitute for the standard math curriculum outperform control classrooms on the math subset of the TerraNova CTBS Basic Batter in a typical setting? The TerraNova is a series of standardized achievement tests designed to measure student achievement in mathematics and other areas (Frey, 2018). The study also sought to answer two exploratory questions 1) What is the effect of Odyssey Math on the math performance differential between male and female students in a typical school setting, and 2) What is the effect of Odyssey Math on the math performance differential between low- and medium/high-scoring students on a math pretest in a typical school setting? The study found no statistically significant difference between classrooms that used Odyssey Math and those that did not on the math subset of the TerraNova Basic Battery.

A quasi-experimental design study was conducted to evaluate the effectiveness of the Saxon Math program in Texas elementary schools using archival data (Resendez et al., 2005). The study consisted of participants in the third, fourth, and fifth grades for 38 sites using the Saxon Elementary Math program and 40 matched comparison sites. Comparison sites were matched using the percent of African American, Hispanic, White, economically disadvantaged, limited English proficient and mobile students. Hierarchical linear modeling and multivariate analysis of covariance was used to answer the following evaluation questions 1) Does math performance improve because of participation in Saxon Elementary Math, 2) Is Saxon Elementary Math associated with improvements for various subgroups, and 3) How does student achievement in math differ across users and nonusers of Saxon Elementary Math? The Texas

Assessment of Academic Skills (TAAS) and the Texas Assessment of Knowledge and Skills (TAKS), which replaced TAAS in 1992, were used in the analyses of outcome measures. The study concluded that the Saxon Elementary Math program is associated with positive outcomes based on the analysis of longitudinal data.

Houghton Mifflin Harcourt (n.d.) conducted a study to better understand the implementation of Math 180 and to examine the achievement outcomes of students who participated in the program in Modesto City schools. The study measured student progress by the average number of software sessions, topics completed, and average time on software per session. The study measured student growth in mathematical knowledge through change in Quantile and performance band on the HMH Math Inventory. Change in Quantile and performance band represent growth in student understanding of important math skills and concepts. The analysis of the two years of Math 180 implementation found that students demonstrated significant levels of growth in their math achievement in Quartile scores on the HMH Math Inventory. The study also found that students who completed more topics made significantly greater gains when student achievement was analyzed by level of progress.

Six middle schools in Hillsborough County Public Schools (Florida) participated in a study to compare math intervention methods. Three of the schools used traditional teaching, and the other three used Math 180 as their remediation tool. Students were assigned to a control group or a treatment group. Math 180 served as the math intervention program for the treatment group. All participants in the study continued in their regular sixth grade math course during the study. Results of the study indicated that students who used Math 180 as an intervention showed greater gains on the post assessments. Through student interviews, students who used Math 180 reported they were more confident with mathematics after the intervention.

Clarke County School District in Las Vegas, Nevada examined the effectiveness of the first of two courses in Math 180. This course focuses on the foundational skills of mathematics. Ninety-seven middle school students used Math 180 as their math intervention for approximately one school year. These students completed a pretest and posttest to determine the impact of Math 180. Students in the control and treatment group had similar pretest scores. The posttest scores revealed that students in the treatment group experience greater growth results on the posttest Houghton Mifflin Harcourt (n.d. e).

Houghton Mifflin Harcourt (n.d.) also conducted a study in Hardin County Schools because the district was interested in understanding the effects of the Math 180 program on student growth in mathematics. The participants in the study were 212 students who participated in Math 180 and 212 matched comparison students from the same schools. The matched comparison students were identified using propensity score matching. Students were stratified by grade, demographic variables and NWEA MAP scores. The baseline equivalence test conducted found no significant difference between the groups based on the variables used during stratification. The research questions for the study were 1) what are the effects of Math 180 in student mathematics achievement 2) how does Math 180 differentially affect subgroups of students, and 3) what is the association between mathematics achievement and program implementation-are changes in Math 180 participants; mathematics test scores associated with variation in program implementation? The measures for the study were Math 180 course software use, Math Inventory scores and NWEA Measures of Academic Progress (MAP) scores. MAP uses a numerical RIT score to measure students' achievement level and compute growth (Northwest Evaluation Association, 2016). The results of the study were that Math 180 students made significantly greater gains than the comparison students based on NWEA MAP scores. As it relates to subgroups the study found that special education students and non-special education students who used the Math 180 program made significantly greater gains than the comparison groups. Lastly, the study concluded that an analysis of Math 180 students' Math Inventory scores revealed that they made significant gains on the assessment between the fall and spring.

This section shows that the effect of computer-based learning on students' mathematics achievement has been studied in state standardized tests and computer adaptive achievement assessments such as the NWEA Measures of Academic Progress and the Houghton Mifflin Harcourt Math achievement test. There is, however, a limited body of research examining the effect of computer-based mathematics programs on the achievement of Black, Hispanic, and low-income students specifically.

Academic Growth versus Academic Achievement

There are efforts being made around the world to improve the academic assessment of students because of increased accountability requirements that examine learning, quality of teachers, quality of teacher education and the quality of schools (Anderman et al., 2015). Academic achievement plays a vital role in determining counties' competitive advantage, knowledge and increasing their citizens well-being. Therefore, public policies have been introduced in recent years that seek to improve students' academic achievement levels. Standardized tests are used to measure performance in education but provide incomplete results. Standardized tests do not consider inputs such as school characteristics, institutional features, available resources, parental education, and parental expectations that impact performance. As public policies seek to improve students' academic achievement levels, they also seek a relatively low degree of inequality in socio-economic outcomes (V. Gimenez et al., 2018).

As further research is conducted it is important to consider assessment uses that promote equity. Assessing academic growth may be more useful than assessing learning at one static point in time. Assessing achievement at a specific point in time makes it difficult to determine the source to attribute the achievement and how much of the achievement is the result of prior knowledge. Achievement results at a specific point time also are not informative about a student's potential to learn or the student’s progress from year to year (Anderman et al., 2015). In opposition assessing student growth measures how learning changes over time within the same student. This is key because students who are in the same grade level or the same age are not necessarily equal developmentally. In contrast to student achievement, student growth takes into consideration the impact of students’ prior knowledge and skills as they change over time. Assessment systems based on development or growth would provide information on a student's individual progress or in comparison to similarly achieving peers (Anderman et al., 2015).

Student growth models are more equitable because students’ initial level of achievement vary, growth is not as strongly related to socioeconomic status as overall achievement, and growth models recognize improvement in student learning not simply achievement (Anderman et al., 2015). Student growth models evaluate variables that impact academic performance such as a student’s environment and beginning academic levels (V. Gimenez et al., 2018).

Conclusion

In closing, this review of literature discussed the theoretical framework and literature related to Title I funding, computer-assisted instruction. It is already known that the technology offers countless opportunities to connect with those outside the school walls. With computer-based learning in classrooms, these connections are at students' fingertips. In the classroom, teachers are replacing visual aids or presentation handouts with documents accessible on each student's computer or mobile device. Because technology devices can be used anywhere, students are likely to engage more often with their academics. Students can study and work and study outside the classroom and have been forced to do it during times of crisis. The more time students spend focused on handheld devices, the more they are capable of learning. Student achievement is measured by what students can do independently. What better way to prepare students with knowledge and self-assurance than to guide them in the direction of a student-centered curriculum? Increased academic achievement is the overall result teachers, parents, and administrators are looking for. Research on computer-assisted instruction has shown it is effective in increasing academic achievement scores. School systems have invested heavily in computer-assisted technology. However, the research literature on the subject leaves an entire sub-group of the population unaccounted for. Based on that conclusion, further research should focus on how the proven benefits of computer-based learning relates to or may benefit middle school math achievement in urban Title I schools.

CHAPTER THREE: METHODOLOGY

Introduction

This study was designed to determine the extent to which students using a computer-assisted instruction program, Math 180, had an increase in mathematic achievement as measured by the Math Inventory assessment and Student Growth Percentiles produced for Georgia Milestones End-of-Grade assessments. This study also examined the extent to which mathematics achievement increased for students using the computer-assisted instruction by various demographic information to determine if differences exist. This section describes the methodology of the study by presenting the research design, setting, school population, instrumentation, data collection and data analysis procedures.

Research Design

This study employed a quantitative descriptive design using secondary data to understand the impact of a computer-assisted instruction program, Math 180, on increasing mathematics achievement of Title I middle school students. Quantitative designs include experimental or non-experimental designs. Nonexperimental designs can be descriptive, descriptive comparative, and correlation. Descriptive studies describe the sample and/or variables without researcher manipulation. According to Siedlecki (2020), descriptive research variables are not manipulated or controlled and there can be more than one outcome variable. Non-experimental designs are beneficial when randomized experiments are not possible or not practical (Loeb et. al, 2017; Millsap & Maydeu-Olivares, 2009). Using non-experimental designs to study the effectiveness of an educational intervention is valuable because randomized controlled trails can be expensive and pose ethical concerns (Gopalan, 2020). According to Gopalan (2020) an ethical concern associated with intervention research is that in randomized control trials some students are denied a possibly beneficial educational intervention (Gopalan, 2020).

The possible aims of descriptive studies are to describe what exists, determine the frequency something happens and discover new meaning (Walker, 2005). The examination of descriptive relationships in quantitative studies involves the collection of numeric data with little or no interaction between the researcher and participants (Parylo, 2012). Although descriptive research designs cannot be used to proclaim a causal relation between variables the research can be used to refute causal claims that do not align with the data. Through productive descriptive analysis the implications can affect policy and practice as well as future research (Loeb et. al, 2017).

Secondary data can be used in descriptive research because of its non-experimental design. Secondary data resources increase the potential for research and have been commonly used in social sciences and education research. Secondary data resources included administrative data, social surveys, longitudinal cohort study databases and cognitive assessment data. This study also used cognitive assessment data which has led to an increased understanding of educational policies and practices (Siddiqui, 2019). Secondary data has benefits such as being cheaper and less time consuming. Secondary data is cheaper and less timing consuming because the researcher does not have to spend time establishing a survey or an experiment because the data that is needed has already been gathered. Another benefit of secondary data is that it may allow for more extensive research as it relate to time and space (Tantawi, 2019). For this study secondary data made it possible to determine the effectiveness of a computer-assisted instruction mathematics intervention program, Math 180, at improving student mathematics achievement scores for eighth grade students enrolled in the program at urban Title I middle schools as measured by the Math Inventory assessment and Georgia Milestones End-Of-Grade over the course of three consecutive school years.

To address the gap in the literature, this study explored if a descriptive relationship exists amongst Math 180 and student achievement outcomes therefore a quantitative, descriptive study was best suited to answer the research questions (Parylo, 2012). Access to a broad body of information can help policy makers at local, state, and national levels and educators make good decisions on how to improve education (Loeb et. al, 2017). There are numerous data collected by the education system which includes student data on attendance, grades, and disciplinary incidents; school data on enrollment, faculty characteristics and class schedules; and state data on revenue, types of schools and academic achievement. Descriptive research can bring meaning to the data by uncovering patterns that inform and improve decision making in education. According to Loeb (2017) descriptive data can help researchers understand phenomenon of interest by explaining the conditions and circumstances of causal research by answering questions about who, what, where, when, and to what extent. Therefore, while descriptive research designs cannot proclaim a causal relationship a combination of causal and descriptive research is important in understanding why an intervention has causal effects.

Setting and Participants

The study was conducted in a large school district just south of Atlanta, Georgia. There are 54 schools in the district, 11 of the schools are high schools and 17 are middle schools. Each school operates Title I school wide programs, which allow schools to upgrade their educational programs and increase student achievement by using federally funded resources (Stone Hill Public Schools, 2020).

Population and Sample. The population for this study was approximately 4000 middle school students in five urban Title I schools. Each school offers a course that uses the Math 180 program which was designed to help students struggling with early mathematics achievement (Scholastic Inc, 2013). During the 2017 – 2018, 2018 – 2019 and 2019 – 2020 school years 146, 110 and 100 students participated in the Math 180 program. The five middle schools in the SHPS district were identified as being urban based on the proximity to a major city, population density, infrastructure of their location. The middle schools are traditional schools serving students from sixth to eighth grade.

The sample for the study was students that were in the eighth grade during the 2017-2018, 2018-2019 and 2019-2020 school year the five middle schools and received the Math 180 intervention. The 356 eighth grade participants were selected by the schools as needing a mathematics intervention (see Table 1). The schools selected students based on previous mathematics performance, including state assessments, and prior mathematics teachers' recommendations. The selection criteria that were used to determine students' need for mathematics intervention and their use of the Math 180 program makes the sample appropriate for the study as it aims to determine the impact of Math 180, a program designed for struggling students, on student achievement outcomes.

Table 1

Demographic Summary by Year

Year	N	Race				
		Black	Hispanic	White	Asian	Other
2017-2018	288	227	49	5	4	4
2018-2019	113	100	8	1	2	2
2019-2020	176	148	17	0	6	5

Math 180 Implementation

Math 180 is a math intervention program specifically designed for students who struggle with math concepts and skills. Math 180 was developed by a team of expert mathematicians with input from key advisors. This team consisted of top university professors: Dr. Deborah Ball (University of Michigan), Dr. Ted Hasselbring (Vanderbilt University), Dr. Sybilla Beckmann (University of Georgia), and Dr. David Dockterman (Harvard University) (Scholastic Corporation, 2014).

Math 180 is structured to produce confidence in mathematics by allowing students to master content at their individualized paces (Scholastic Corporation, 2014). These math skills are necessary to meet the demands of rigorous standardized assessments. Middle school students are generally expected to be proficient in algebra readiness and problem-solving skills prior to entering high school. Math 180 targets the development of strong mathematical skills and practices (Scholastic Corporation, 2014). It uses real-world situations to learn key concepts needed to be prepared for life after secondary school. The goal of the founders of Math 180 was to develop a mathematics intervention that equipped students struggling in mathematics with knowledge, confidence, and motivation to excel in high school mathematics and become college and career ready (Scholastic Corporation, 2014). The mathematics program is based on three research-based principles: focus on what matters most, force multiplier for teaching, and have a growth mindset.

The first principle is to accelerate student learning by focusing on essential concepts and skills required in preparation for algebra. Reteaching every concept or skill a student missed is not plausible. The second principle is to build teacher effectiveness by helping them become force multipliers, a combination of factors, by embedding Dr. Deborah Ball's High Leverage practices into every lesson, the Teaching Guide and, Student Achievement Manager (SAM) Central and the teacher dashboard. Reports by Scholastic Inc. (2013) stated that High-Leverage Teaching Practices serve as professional learning to improve teacher effectiveness. The third principle is that attitudes toward intelligence can impact performance so Math 180 works to foster students' development of a growth mindset. Math 180 incorporates Dr. Carol Dweck's Mindset Works into the program to help students and their teachers move from the "fixed mindset" that success in math is not possible to a "growth mindset" concepts (Scholastic Corporation, 2014). Students will learn that intelligence is malleable and build their confidence.

A typical class is structured to begin with a whole class "Do Now", which develops mathematical thinking and connects to previously learned concepts (Scholastic Corporation, 2014). Next the class is divided into two groups. One group receives group instruction while the other group uses the personalized adaptive software. The group instruction is to help students build conceptual understanding, develop reasoning skills, communication skills and interpret student thinking. The Math 180 personalized software is adaptive so that students that need more practice receive it while those who need acceleration move forward. These two groups rotate after 20 to 25 minutes (Scholastic Corporation, 2014).

Math 180 focuses on specific sets of concepts and mathematical practices. It uses the eight standards for mathematical practice to accelerate learning and develop deep conceptual understanding. The concentration is on concepts along the progression to algebra. Students begin to understand how math is interdependent and cumulative in nature. The rigor is increased with opportunities for mathematical reasoning and higher-order thinking. Students learn to communicate mathematically with a richer math vocabulary. Older students who have not been successful in mathematics are able to focus on what matters most and build foundations to improve math competency. They learn to make connections and apply their understanding into new contexts.

Math 180 uses technology to provide data-powered differentiation. This enables the accommodation of students with a variety of abilities, interests, and learning needs. Students with special needs may receive supports in Math 180 that they may be unable to receive in a traditional classroom setting. Students are provided ongoing formative assessments and progress monitoring. Teachers receive interactive reports with recommendations, resources, and lesson plans to enhance student learning. These reports allow teachers to see growth and progress towards mastery.

Math 180 encourages a growth mindset by improving student attitudes towards mathematics. Students receive positive praise for working hard and persevering through the program. They learn that making a mistake is a natural part of learning. Through Math 180, students develop a mindset that over time their math abilities will improve through effort and dedication. Math 180 presents concepts in ways that give purpose and value to mathematics. Math 180 also allows students to experience success by mastering concepts through practice.

Math 180 is a comprehensive personalized learning system of curriculum, instruction, and assessment tailored to engage and motivate students using technology. Students are not only motivated, but they play an integral part by taking ownership of their own learning. Previous research as discussed Chapter 2 suggests that Math 180 may increase student achievement in mathematics (Scholastic Corporation, 2014).

Each of the five middles schools provided struggling students with the Math 180 intervention as an elective course for an hour every day throughout the school year in addition to their required mathematics class. Students were provided a computer to access the Math 180 software during class.

Measurement

Two assessments were used for this study, Math Inventory scores and Student Growth Percentiles from the Georgia Student Growth Model based on the Georgia Milestones assessment. The Math Inventory assessment was used for the pretest scores and posttest scores. The Math Inventory assessment is built into the Math 180 program (Scholastic Inc., 2013), however; the Georgia Milestones assessment is not. Student Growth Percentiles use prior Criterion-Referenced Competency Test data or Georgia Milestone assessment data to generate a growth percentile (Georgia Department of Education, 2014).

Math Inventory. Math Inventory is a computer adaptive assessment included in the Math 180 program that measures student mathematics achievement and growth from Kindergarten to Algebra 2 (Scholastic Inc., 2013). The assessment's item bank consists of 5,000 questions aligned to grade level state standards. The assessment measures student growth in mathematical knowledge using the Quantile Framework for Mathematics, "a scientific taxonomy of more than 500 math concepts and skills that places students' readiness for math instruction and the difficulty of math tasks on the same scale (RMC Research, 2020, pg.3)." Math Inventory is given 3-5 times per year to benchmark students' math progress at key intervals (Math Solutions, 2020). Student Achievement Manager (SAM) Central, a platform provide by Scholastic for teachers, provides access to student data from the Math 180 program and Math Inventory assessments. The SAM Central platform allows Math Inventory Reports to be organized into individual, class, school, or district data reports. The reports can give information on students' performance level and growth (Math Solutions, 2020).

The assessment adapts in difficulty based on students' responses as 30 questions are completed. The reports provided are criterion-referenced, which measures proficiency based on individual achievement and norm-referenced terms, which produces an order of student ranking in a relation to a group (Lok et. al, 2016 & Math Solutions, 2020). The Math Inventory assessments' alignment with the Math 180 program and state grade level standards justifies it use a measure of achievement to examine the effect of the program.

Georgia Milestones Assessment System. According to the Georgia Department of Education (n.d.) the Georgia Milestones Assessment System is a summative assessment program for students in third grade to high school. The Georgia Milestones measures students' knowledge and skills based on state standards for English language arts, mathematics, science, and social studies. The Georgia Department of Education (n.d.) also stated that elementary and middle school students enrolled in non-high school courses in grades three through eight will take end-of-grade assessments in English language arts and mathematics. Students in grades 5 and 8 must also take end-of-grade assessments in science and social studies. Lastly, high school students and students enrolled in the 10 courses designated by the State Board of Education will take an end-of-course assessment. End-of-grade assessments and end-of-course assessments are taken during local testing windows, which are selected by the district and must fall within the state designated testing window (Georgia Department of Education, n.d.).

The goal of the Georgia Milestones Assessment System according to the Georgia Department of Education (n.d.) is to provide information about students' mastery of the content described in state standards. To aid in this goal Georgia educators developed achievement levels that describe students' mastery based on their scale score. There are four achievement levels that paint a clear picture of students' knowledge and skills by providing descriptions of the knowledge and skills students must demonstrate to achieve at each level. The four levels are Beginning Learners, Developing Learners, Proficient Learners and Distinguished Learners. Their descriptions provide information on levels of proficiency and preparedness for the next grade or course. Beginning Learners do not demonstrate proficiency and need substantial academic support, Developing Learners demonstrate partial proficiency and need additional academic support, Proficient Learners demonstrate proficiency and are prepared, and Distinguished Learners demonstrate advanced proficiency and are well prepared.

The Georgia Student Growth Model provides information about student growth. Student growth data provides a more complete picture of students' academic performance than just achievement alone. Student Growth Percentiles (SGPs) describe the amount of growth a student has demonstrated relative to a cohort of academically similar students across the state. The growth model uses two years of previous data as pretest scores. One year of data is used if two years are not available. If data is not available for the year immediately before, the model does not produce a growth percentile. The Georgia Student Growth Model provides all students with the ability to show growth regardless of their achievement level (Georgia Department of Education, 2014). The Georgia Student Growth Model utilizes three student growth level categories based on observed growth scores. They are low (1- 34), typical (35-65), and high (66-99). According to the Georgia Department of Education (n.d) SGPs can be used in addition to other information about student performance to improve student learning, instruction, and educational programs.

The Grade 8 Mathematics End of Grade (EOG) assessment is a part of a system of summative assessments, which are intended to summarize what students have learned after instruction, administered in the state's educational systems that assess students' mastery of state standards for a particular course or grade (Georgia Department of Education, 2014 & Myers, 2021). The Georgia Milestones Assessment System is summative assessment program purposed to provide information about students' mastery of state adopted standards in content areas. The Georgia Milestones provides important information about students' achievement and their readiness for the next level. Information from the Georgia Milestones informs stakeholders how well students are learning and is an essential part of Georgia's educational assessment and accountability system. The information provided by the Georgia Milestones can help school districts and boards of education measure the quality of educational opportunity being provided throughout the state (Georgia Department of Education, 2014). The performance and progress of schools and districts in Georgia and the state is provided to all stakeholders by the Accountability Division of the Georgia Department of Education. It is also the responsibility of the Accountability Division to ensure that Georgia meets the accountability requirements of The Every Student Succeeds Act (Georgia Department of Education, 2014b).

The Georgia Milestones is a key component of the College and Career Ready Performance Index (CCRPI), which is Georgia's accountability system (Georgia Department of Education, 2014). Georgia uses CCRPI as a tool to measure how well schools, districts and the state are preparing students for college and careers. The major components of the CCRPI are Achievement, Progress, Closing Gaps, Readiness, and in high schools Graduation Rate. These components are scored on a scale ranging from 0 to 100 (Georgia Department of Education, 2014b). The achievement component uses scores from the Georgia Milestones which makes it an important measure of student achievement.

Validity and Reliability

Math Inventory. According to Math Solutions (2020) Math Inventory is a research-based system, which received the highest rating for validity and reliability by the Center in Response to Intervention at American Institutes for Research. The validity of the content that the Math Inventory is based on clear connections to the concepts and skills described by national and state level mathematics standards. Student results on the Math Inventory are satisfactorily correlated with their results on state assessments according to validity estimates. The reliability of the Math Inventory assessment is 0.97 as measured by the marginal reliability calculation appropriate for computer adaptive assessments. The test-retest reliability coefficient was 0.78, which is in the range established as satisfactory. The Math Inventory assessment received the highest rating for outcomes of reliability of performance level score because the data is stable, consistent, and dependable. It also received the highest rating for validity of the performance level score because it measures what it claims to measure (Math Solutions, 2020).

Georgia Milestones. According to the Georgia Department of Education (2018), the department that oversees the development of the Georgia Milestones Assessment Systems, the system adheres to the Standards for Educational and Psychological Testing to address issues of validity and reliability. The purpose of the standards are to encourage tests to be used well and ethically and to serve as a basis to evaluate the quality of teaching practices. The Georgia Milestones assessment is a measure of students' mastery of the state's content standards. It also identifies were students need improvement by informing stakeholders of students' progress toward meeting state achievement standards. With these intended purposes validity of this test depends on alignment to the content standards. Therefore, the concepts, knowledge and skills that will be assessed and how they will be assessed is determined using the approved published documents for the content standards and committees of Georgia educators. Then assessment guides, blueprints and content weights are posted publicly, serving as evidence of the validity of the Georgia Milestones. Next items are written by assessment specialists and reviewed for curriculum alignment by Georgia educators. Accepted items are field tested then examined again by another committee of Georgia educators. During the second review items are analyzed further for potential bias based on how different groups performed. If items are accepted at this point of the development process, they are entered into the item bank for future tests. Next the test is developed by selecting items based on the Georgia Milestones Test Blueprint and Content Weight documents. During this last stage of test development scores are produced and results are distributed along with interpretation and use guides available on the Georgia Department of Education website. This development process ensures that the Georgia Milestones Assessment Systems uses valid instruments for the intended use of the test. A test must not only be valid for its intended use, but it must also be reliable. The Cronbach's alpha reliability coefficient was used as a reliability measure for the Georgia Milestones Assessment system. The average, minimum and maximum reliability values range from 0.89 to 0.93 on Georgia Milestones assessments which suggest the assessments are reliable for the intended purpose (Georgia Department of Education, 2018).

Data Collection

Data for this study was collected using secondary data from the Houghton Mifflin Harcourt (HMH) data base of Math Inventory scores and the State Longitudinal Data System (SLDS). The researcher received permission from the district's Research and Review Board and

Kennesaw State University's Institutional Review Board to access the data. Students enrolled in the Math 180 program were required to take the Math Inventory assessment 3 to 5 times per year. Score reports from HMH were used to compare Math Inventory pretest and posttest results.

Previous academic performance and teacher recommendations were used to determine if students would receive the Math 180 intervention. Students were enrolled in a mathematics course that would use the Math 180 program to provide instruction. Secondary data was gathered from HMH to compare students pretest and posttest scores results based on the Math Inventory assessment from students enrolled in the Math 180 program. The data collected from HMH was students Math Inventory scores and total time spent using the Math 180 program throughout the school year.

Data Analysis Procedures

Data analysis for this study were conducted using SPSS, a statistical software program. To answer Research Question 1, a multiple linear regression analysis was used to determine if the independent variables, pretest scores and total time, using the Math 180 program predicted the dependent variable, posttest scores. To answer Research Question 2, an independent samples t-test was used to test whether a significant difference between the independent variable, demographic groups, for the change in mathematics proficiency based on the dependent variables, Math Inventory pretest and posttest scores, when using the Math 180. To answer Research Question 3, univariate analysis was used to provide the frequency distribution of student performance at each growth level category based on SGPs. The Math Inventory data that was collected was the quantile performance level for the pretest scores and posttest scores for each student in the sample. The State Longitudinal Data System (SLDS) was used to collect student subgroup data and SGP data for each student.

Limitations and Assumptions

Limitations. There are several limitations of the study. The first limitation is the sample size and sample used in this study, which need to be considered prior to attempting to generalize the results to student populations. The sample for this study was eighth grade students enrolled in the Math 180 program at five urban Title I schools. This convenience sampling limits the generalization of the results of the study to other populations, such as other grade levels. A second limitation is that the research will only use secondary quantitative data since past years of implementation are being studied. Qualitative data could provide context from the results gained from using quantitative data. Lastly, the high transiency of the district may impact sampling and cause some student data to be incomplete and not included in the study.

Assumptions. The researcher made two assumptions regarding the implementation of the Math 180 intervention during the years being studied. The first assumption is that the Math 180 program was implemented with fidelity. The second assumption was that teachers received the same amount of professional development and guidance from Math Solutions.

Ethical Considerations

Ethical considerations for secondary data analysis include confidentiality and security of the students' achievement and personal data. A request was made to the school district that the data be de-identified prior to being released. To avoid ethical issues and challenges data was kept safe from unauthorized access, accidental loss, or destruction. All hardcopies of data were kept in safe locked cabinets and electronic files were kept on a secured computer (Tripathy, 2013). The research ensured that further analysis of the data conducted is appropriate according to FERPA regulations and in adherence to all IRB specifications.

Prior to the beginning the study, the application process to conduct research in CCPS according to the guidelines established by CCPS Research and Review Board (RRB) was completed. Once permission was given from the CCPS RRB, the approval process from the Institutional Review Board of Kennesaw State University to conduct the study was completed. The district provided access to the student data, Math Inventory scores and Student Growth Percentiles after the IRB applications were approved.

Summary

This section discussed the methodological approach that this study used. Research questions were listed at the beginning of this section. This section also included the research design, participants, setting, school populations, instrumentation, data collection and data analysis procedures. Value of specific methodology, limitations and assumptions were also addressed.

CHAPTER FOUR: RESULTS

The purpose of this study was to examine the effectiveness of a computer-assisted instruction mathematics intervention program, Math 180, at improving student mathematics achievement scores for eighth grade students enrolled in the program at urban Title I middle schools as measured by the Math Inventory assessment and Georgia Milestones End-Of-Grade assessment using secondary data obtained from the school district.

Assumptions

The researcher analyzed the Math Inventory pretest scores, posttest scores and total time spent in the program to ensure the assumptions of multiple regression were met. The assumptions include level of measurement, sample size, independent residuals, normality, linearity, homoscedasticity, and multicollinearity. The two independent variables, total time and pretest scores are continuous variables, and the dependent variable, posttest score, is continuous satisfying assumption one for each school year.

Tabachnick and Fidell (2007) stated the sample size must satisfy explicit equations for a full regression model and for testing individual independent variables. There must be at least 50 + 8(k) for a full regression model or 104 + k for testing independent variables. Therefore, n must be at least 50 + 8(2) = 66 for a full regression model and 104 + 2 = 106 for testing independent variables, 50 + 8(2) = 66 for a full regression model and 104 + 2 = 106 for testing independent variables and 50 + 8(2) = 66 for a full regression model and 104 + 2 = 106 for testing independent variables for the 2017-2018, 2018 – 2019 and 2019 – 2020 school years, respectively.

Data from a total of 146 students for the 2017 – 2018 school year, 110 students for the 2018 – 2019 school year and 100 students for the 2019 – 2020 school year were included in this research, which satisfies Tabachnick and Fidell’s (2007) equations for determining sufficient sample size. In addition, an analysis of standard residuals was carried out, which indicated that a participant needed to be removed from each of the 2017 – 2018 and 2019 – 2020 school years. For the 2018 – 2019 school year an analysis of standard residuals was carried out, which showed that the data contained no outliers (Std. Residual Min = -3.13, Std. Residual Max = 2.73). The Durbin-Watson statistic showed that the values of the residual are independent, as the obtained values were close to 2 for each school year (Durbin – Watson = 1.66, 2.11 and 1.83). The histogram of standardized residuals for each school year indicated that normality is reasonably evident (see Figures 1, 2 and 3) . The normal probability plot indicates greater evidence of normality for the residuals as the residuals exhibit only a minor departure from the line (see Appendix A). Therefore, estimations of correlations were more reliable and stable.

The scatterplots of standardized predicted values for each school year showed no evidence of nonlinear patterns shown in Appendix B and Appendix C. Therefore, the linearity assumption is met for the dependent variable, posttest scores and each of the independent variables, pretest scores and total time.

The scatterplot of standardized residuals vs standard predicted values for pretest scores for each school year showed no obvious signs of funneling or fanning. The scatterplot of standardized residuals versus standard predicted values for total time during the 2017 – 2018 school year did show minor signs of funneling providing minimal evidence for heteroscedastic errors. For each of the subsequent school years the scatterplot of standardized residuals versus standard predicted values for total time showed no obvious sign of funneling or fanning,

Tests to see if the met the assumption of collinearity indicated that multicollinearity was not a concern because the Tolerance and VIF of total time and pretest scores were equal to 1 for the 2017 – 2018 school year. Multicollinearity was not a concern for the 2018- 2019 school year

(Pretest Scores, Tolerance = .99, VIF = 1.01; Total Time, Tolerance = .99, VIF = 1.01) nor the 2019- 2020 school year. (Pretest Scores, Tolerance = .99, VIF = 1.01; Total Time, Tolerance = .99, VIF = 1.01) since the VIF value is less than 10 and the Tolerance is greater than 0.1.

Figure 1

Histogram of Standardized Residuals for the 2017-2018 School Year

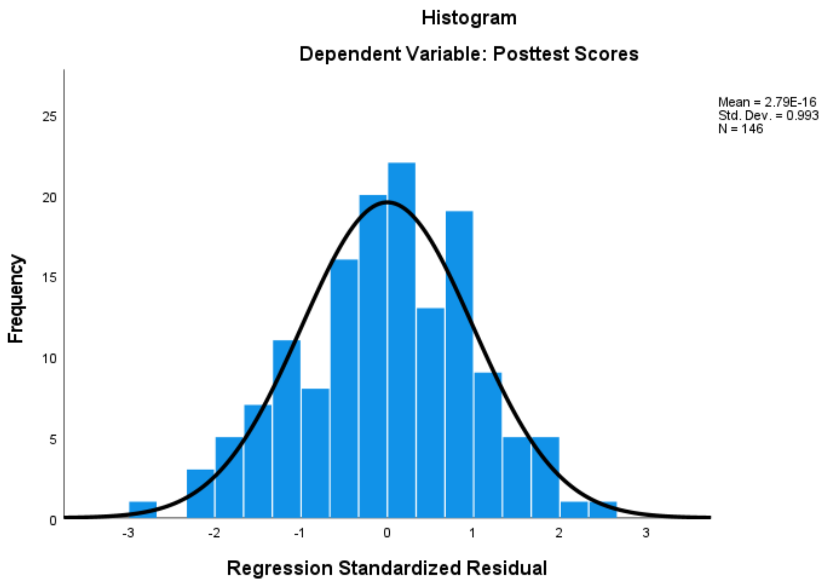


Figure 2

Histogram of Standardized Residuals for the 2018-2019 School Year

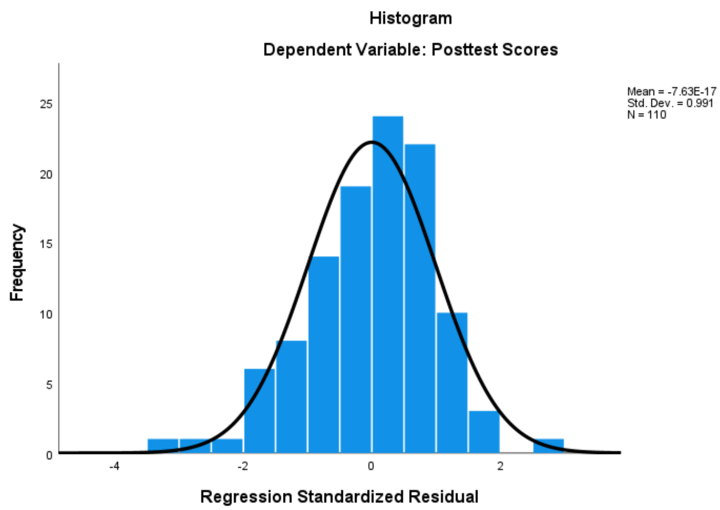
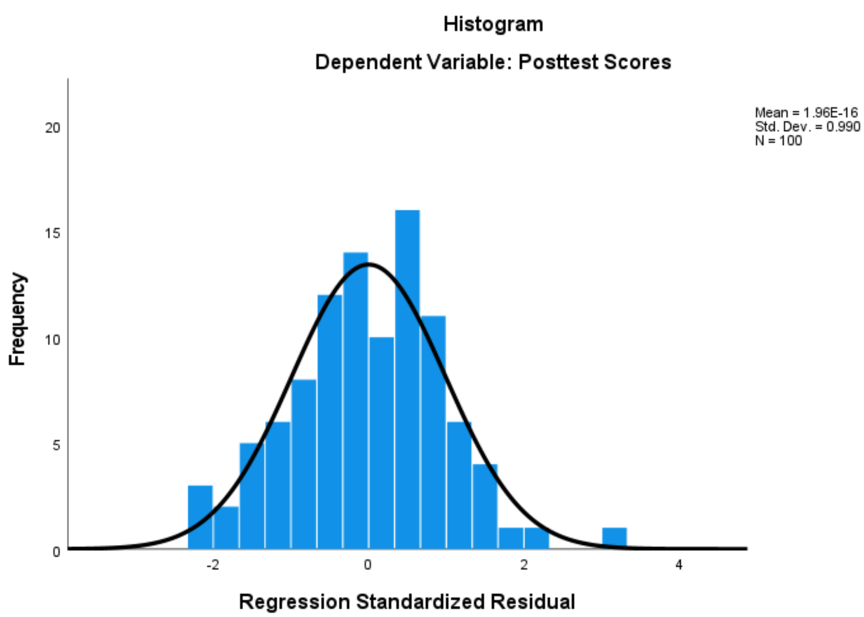


Figure 3

Histogram of Standardized Residuals for the 2019-2020 School Year



For the 2017-2018 school year there were data for 288 eight grade students who were enrolled in the Math 180 program; however, not all students had pretest scores, posttest scores and total time spent using the program. An additional data set was excluded to prevent the influence of bias. So, 146 (n=146) data sets were used. The average pretest score on the Math Inventory assessment was 570.3 and the average posttest score was 690.6. The average number of minutes students used the Math 180 program was 1259.8.

Similarly for the 2018-2019 school year there were data for 113 eight grade students who were enrolled in the Math 180 program, not all students had pretest scores, posttest scores and total time spent using the program. So, 110 (N=110) data sets were used. The average Pretest score on the Math Inventory assessment was 542.64 and the average posttest score was 638.64. The average number of minutes students used the Math 180 program was 889.95.

For the 2019-2020 school year there were data for 176 eight grade students who were enrolled in the Math 180 program, not all students had pretest scores, posttest scores and total time spent using the program. So, 100 (N=100) data sets were used. The average Pretest score on the Math Inventory assessment was 693.76.64 and the average posttest score was 724.50. The average number of minutes students used the Math 180 program was 909.99.

Table 2

Descriptive Statistics for Students Enrolled in Math 180

Year	Variable	N	Mean	Std. Deviation
2017-2018	Pretest Score	146	570.34	193.06
	Total Time in Minutes	146	1259.79	805.18
	Posttest Score	146	690.55	204.48
2018-2019	Pretest Score	110	542.64	215.54
	Total Time in Minutes	110	889.95	1039.13
	Posttest Score	110	638.64	235.16
2019-2020	Pretest Score	100	693.76	104.75
	Total Time in Minutes	100	909.99	965.71
	Posttest Score	100	724.50	94.14

Results

Research Question 1. To what extent is the computer-assisted instruction program effective for improving mathematical proficiency in Title I urban school?

Table 3

Model Summary

Year	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
2017 - 2018	1	532[a]	0.283	0.273	174.317
2018 – 2019	1	546[a]	0.299	0.286	198.771
2019 - 2020	1	504[a]	0.254	0.239	82.124

a. Predictors: (Constant), Pretest Scores, Total time
b. Dependent Variable: Posttest Scores

Table 4

Regression Analysis for Pretest Scores and Total Time Predicting Posttest Scores

	Variable	B	95% CI	β	t	p
2017-2018	(Constant)	327.23	[226.15, 428.32]		6.40	.000
	Pretest Scores	.54	[.39, .69]	.51	7.17	.000
	Total Time	.05	[.01, .08]	.18	2.50	.014
2018-2019	(Constant)	344.57	[233.80,455.33]		6.17	.000
	Pretest Scores	.58	[.40,.75]	.53	6.49	.000
	Total Time	-.02	[-.06,.02]	-.09	-1.15	.254
2019-2020	(Constant)	408.48	[298.19, 518.78]		7.35	.000
	Pretest Scores	.45	[.29, .60]	.50	5.66	.000
	Total Time	.01	[-.01, .02]	.07	.81	.423

Note. CI Confidence Interval for B

Multiple regression analyses were used to test if Total Time and Pretest scores significantly predicted students' Last Quantile scores for the 2017 – 2018, 2018 – 2019 and 2019 – 2020 school year. As a result of using two predictors the regression equation is:

$Y = a + b_1X_1 + b_2X_2$, where Y is Posttest Scores, $X_1$is Pretest Scores, and $X_2$is Total time.

Specifically, the regression equation is $PosttestPredicted\ =\ 327.233\ +\ .045 \cdot TotalTime\ +\ .538 \cdot Pretest$ for the 2017-2018, $PosttestPredicted\ =\ 344.565 -\ .021 \cdot TotalTime\ +\ .577 \cdot Pretest$ for the 2018 – 2019 school year and $PosttestPredicted\ =\ 408.482\ +\ .007 \cdot TotalTime\ +\ .466 \cdot Pretest$ for the 2019 – 2020 school year.

The results of the multiple linear regression analysis for the 2017 – 2018 school year indicated Pretest scores and Total Time predicted students' performance on the Posttest scores. It explained 28.3% of the variance (R^2=.283, F(2,143)=28.26, p<.01). For the 2017 – 2018 school year it was found that Pretest scores significantly predicted Posttest scores (b=.54, β = .51, p<.001) and total time (b=.05, β=.18, p<.05) was a significant predictor of student Posttest scores.

The results of the multiple linear regression analysis for the 2018 – 2019 school year indicated only Pretest scores predicted students' performance on the Posttest scores. It explained 29.9% of the variance (R^2=.299, F(2,107)=22.78, p<.01). For the 2018 – 2019 school year it was found that Pretest scores significantly predicted Posttest scores (b=.58, β = .53, p<.001) and Total Time (b=-.02, β=-.09, p>.05) was not a significant predictor of student Posttest scores.

The results of the multiple linear regression analysis for the 2019 – 2020 school year indicated only Pretest scores predicted students' performance on the Posttest scores. It explained 25.4% of the variance (R^2=.254, F(2,97)=22.78, p<.01). For the 2019 – 2020 school year it was found that Pretest scores significantly predicted Posttest scores (b=.47, β = .50, p<.001) and Total Time (b=.01, β=.07 , p>.05) was not a significant predictor of student Posttest scores.

Research Question 2. To what extent is the computer-assisted instruction program effective for improving mathematics performance in Title I urban schools by ethnicity?

To answer research question 2 a binary variable was used to reflect the difference in conditional means between Black and non-Black students (coded 0 = Black, 1 = non-Black) and between Hispanic and non-Hispanic students (coded 0 = Hispanic, 1 = non – Hispanic).
An independent samples t-test was used to test whether a significant difference between demographic groups for the change in mathematics proficiency when using the Math 180 program. Based on a sample of 119 Black students and 27 non-Black students collected from eighth grade students using the Math 180 program in urban Title I middle schools during the 2017 – 2018 school year, the mean score change for Black students was 129.83 with a standard deviation of 203.32, and the mean score change for non-Black students was 77.78 with a standard deviation of 173.58. When comparing these two means in the sample, the independent t-test was shown not statistically significant (t=1.232, *df* = 144, *p* > .05). Similarly, a sample of

25 Hispanic students and 121 non-Hispanic students collected from eighth grade students using the Math 180 program in urban Title I middle schools during the 2017 – 2018 school year, the mean score change for Hispanic students was 76.00 with a standard deviation of 176.90, and the mean score change for non-Hispanic students was 129.34 with a standard deviation of 202.30. When comparing these two means in the sample, the independent t-test was shown not statistically significant (t=-1.224, *df* = 144, *p* > .05).

Further analysis of the research question was conducted based on a sample of 98 Black students and 12 non-Black students collected from eight grade students using the Math 180 program in urban Title I middle schools during the 2018 – 2019 school year, the mean score change for Black students was 150 with a standard deviation of 188.79, and the mean score change for non-Black students was 89.39 with a standard deviation of 220.35. When comparing these two means in the sample, the independent t-test was shown not statistically significant (t=.912, *df* = 108, *p* > .05). Similarly, a sample of 8 Hispanic students and 102 non-Hispanic students collected from eighth grade students using the Math 180 program in urban Title I middle schools during the 2018 – 2019 school year, the mean score change for Hispanic students was 91.76 with a standard deviation of 217.63, and the mean score change for non-Hispanic students was 150 with a standard deviation of 217.81. When comparing these two means in the sample, the independent t-test was shown not statistically significant (*t*=-.729, *df* = 108, *p* > .05).

Lastly an analysis of the research question was conducted based on a sample of 89 Black students and 11 non-Black students collected from eight grade students using the Math 180 program in urban Title I middle schools during the 2019 – 2020 school year, the mean score change for Black students was 150 with a standard deviation of 188.79, and the mean score change for non-Black students was 89.39 with a standard deviation of 220.35. When comparing these two means in the sample, the independent t-test was shown not statistically significant (t=.912, df = 108, $p > .05$). Similarly, a sample of 8 Hispanic students and 102 non-Hispanic students collected from eighth grade students using the Math 180 program in urban Title I middle schools during the 2018 – 2019 school year, the mean score change for Hispanic students was 91.76 with a standard deviation of 217.63, and the mean score change for non-Hispanic students was 150 with a standard deviation of 217.81. When comparing these two means in the sample, the independent t-test was shown not statistically significant (t=-.729, df = 108, $p > .05$).

Table 5

Pretest and Posttest Scores Across Groups

	N	Mean	SD	Sig	*t*	*df*
2017-2018						
Black	119	129.83	203.32			
Non-Black	27	77.78	173.58	.317	-1.232	144
Hispanic	25	76.00	176.90			
Non-Hispanic	121	129.34	202.30	.465	1.224	144
2018-2019						
Black	98	150.00	188.79			
Non-Black	12	89.39	220.35	.468	.912	108
Hispanic	102	91.76	217.63			
Non-Hispanic	8	150.00	217.81	.881	-.729	108
2019-2020						
Black	11	69.64	61.42			
Non-Black	89	25.93	102.92	.148	1.38	98
Hispanic	93	27.13	101.18			
Non-Hispanic	7	78.71	70.03	.343	-1.32	98

Research Question 3. How often do Math 180 students experience low growth, typical growth and high growth on the Georgia Milestones End-of-Grade assessment based on student growth percentiles?

Using ordinal variables, which represent a rank ordering of student growth percentiles, frequency percentages for the 2017 – 2018 and 2018 – 2019 school year were obtained and are represented in the bar charts below (see Figure 4). During the 2017 – 2018 school year approximately 30 percent of students experienced low growth, 26 percent experienced typical growth and 26 percent experience high growth. During the 2018 – 2019 school year approximate 22 percent of student experienced low growth, 27 percent experienced typical growth and 16 percent experienced high growth. During the 2019 – 2020 school year Student Growth Percentiles were not calculated because students did not take the Georgia Milestone due to the coronavirus pandemic. It is also important to note that the growth model does not produce a growth percentile for students that do not have Georgia Milestone assessment data available from the year prior. Therefore, all 356 participants were not assigned SGPs that could be used for this study.

Figure 4

Bar Chart of Student Growth Percentiles

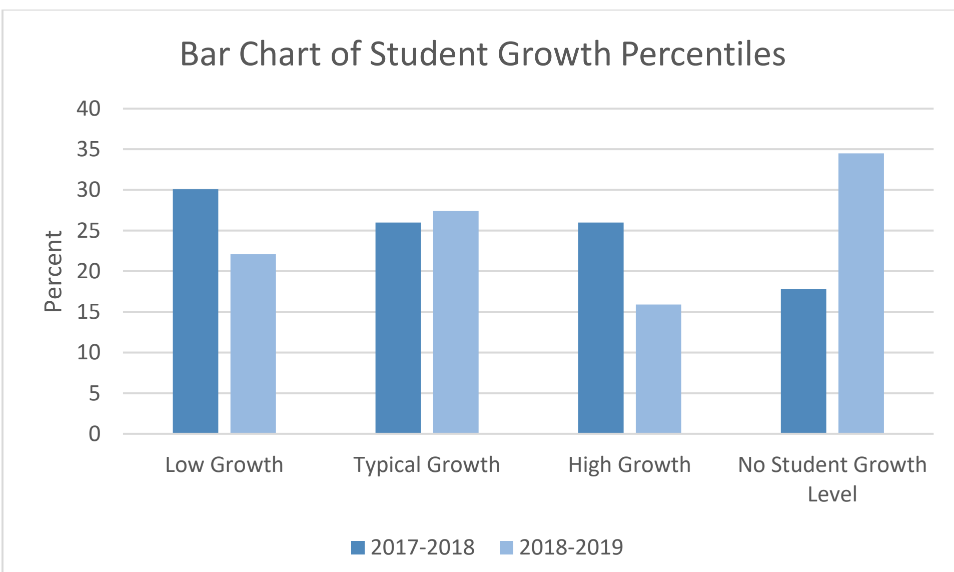


Table 6

Student Growth Percentile Frequencies

Student Growth Levels	2017-2018		2018-2019	
	n	%	*n*	%
Low Growth	44	30.1	25	22.1
Typical Growth	38	26.0	31	27.4
High Growth	38	26.0	18	15.9
No Student Growth Level	26	17.8	39	34.5

CHAPER FIVE: DISCUSSION

This study explored the impact of a computer-assisted instruction program, Math 180, on student achievement in urban Title I middle schools. The purpose of this chapter is to provide an overview of the study, interpretation of the findings, implications, recommendations for future research and a conclusion.

Overview

The achievement of students in urban schools is significantly lower than students in suburban schools (Sirin, 2005). Therefore, efforts are being made to increase the performance of students who attend urban schools. A large portion of students who attend urban schools come from low-income households (Neild & Balfanz, 2006). When 40 percent of the students at a school are identified as coming from a low-income household the school is designated as a Title I school (Phillips, 2019). Each school in this study has been designated as a Title I school. Title I schools receive federal funds aimed to benefit students by giving them an opportunity to succeed academically and by aiding schools as they strategize to improve instruction (Ysseldyke et. al, 2004). ESSA requires that districts and schools use evidenced based activities, strategies, and interventions to increase the impact of investments (Herman et al., 2017). Stone Hill Public Schools selected a computer-assisted instruction program as an intervention to improve low levels of mathematics achievement. Therefore, the purpose of this study was to examine the effectiveness of a computer-assisted instruction intervention program, Math 180, at improving student mathematics achievement scores for eighth grade students enrolled in the program at urban Title I middle schools as measured by the Math Inventory assessment and the Georgia Milestones End-Of-Grade assessment using secondary data obtained from the school district.

As previously stated, research has found that computer-assisted instruction is a popular choice to improve mathematics achievement (Barrow et. al, 2009). Computer-assisted instruction offers highly individualized instruction allowing students to work at their own pace which has been shown to be more effective than traditional classroom instruction (Barrow et. al, 2009). As schools and districts look for solutions to the ongoing disparities in measures of educational performance as it relates to students from low-income families, Black students and Hispanic student performance on standardized tests when compared with their White and middle to upper-class peers it is important that interventions that are intended for educational improvement are effective (Herman et. al, 2017). Moving past traditional methods of rote memorization and learning can benefit all students especially students struggling to learn mathematics by allowing them to work at their own pace and by countering the disruptive effects of larger class sizes and chronic absenteeism, which are common in urban schools (Barrow et. al, 2009; Mireles-Rios et. al, 2020; Roofe, 2018).

Interpretations of the Finding

This study sought to answer three research questions regarding the impact of Math 180 in Title I middle schools in an urban school district. Multiple regression, t-test and descriptive statistics were used to analyze data related to research questions 1, 2 and 3, respectively. The first question asked to what extent is the computer-assisted instruction program effective for improving mathematical proficiency in Title I schools. Multiple regression was calculated using two independent variables (pretest scores and total time) and a dependent variable (posttest scores).The multiple regression outcome indicated that during the 2017 – 2018 school year pretest scores and time spent using the Math 180 program significantly predicted posttest scores. This would mean that students gained mathematical knowledge between the Math Inventory pretest and the Math Inventory posttest possibly through the use of the Math 180 program. During the 2018-2019 and 2019-2020 school year pretest scores significantly predicted posttest scores but total time using the Math 180 program did not significantly predict posttest scores. Meaning that students did gain mathematical knowledge; however, gains cannot be attributed to the use of the Math 180 program. As discussed in Chapter 2, there are computer-assisted instruction programs that have been shown to increase mathematics achievement while others have not which makes this research an important part of conversations on continuing or discontinuing use of the Math 180 program in the SHPS district.

The second research question asked to what extent is the computer-assisted instruction program effective for improving mathematical proficiency in Title I schools by ethnicity. Black students when compared to non-Black students and Hispanic students when compared to non-Hispanic student scored lower on the post-test during each school year, except for the 2017-2018 school year in which Black students scored higher on the posttest than non-Black students. These differences were not significant. Other demographics group sizes such as non-Black or non-Hispanic students, English Learners and Students with Disabilities were too small to analyze for this particular research question. The data revealed that there are differences in scores between demographic groups. However, the results imply that the Math 180 program was not more or less beneficial for improving mathematical proficiency for Black students when compared to non-Black students and Hispanics students when compared to non-Hispanic.

The third research question asked how often Math 180 students experienced low growth, typical growth or high growth on the Georgia Milestones End-of-Grade assessment based on student growth percentiles. During the 2017 – 2018 school year approximately 30 percent of students experienced low growth, 26 percent experienced typical growth and 26 percent experience high growth. Meaning that 30 percent of the students grew at a rate greater than at least 1 percent of academically-similar students in mathematics, 26 percent of the students grew at a rate greater than at least 35 percent of academically-similar students in mathematics and 26 percent of the students grew at a rate greater than at least 60 percent of academically-similar students in mathematics during the 2017 – 2018 school year. During the 2018 – 2019 school year approximate 22 percent of student experienced low growth, 27 percent experienced typical growth and 16 percent experienced high growth. Meaning that 22 percent of the students grew at a rate greater than at least 1 percent of academically-similar students in mathematics, 27 percent of the students grew at a rate greater than at least 35 percent of academically-similar students in mathematics and 16 percent of the students grew at a rate greater than at least 60 percent of academically-similar students in mathematics during the 2017 – 2018 school year. All 356 participants were not assigned SGPs during the 2017-2018 and 2018-2019 school year because the growth model does not produce a growth percentile for students that do not have Georgia Milestone assessment data available from the year prior. During the 2019 – 2020 school year Student Growth Percentiles were not calculated because students did not take the Georgia Milestone due to the coronavirus pandemic.

Constructivism is one of the theories that frames this research as stated in the theoretical framework. Constructivism focuses on a learner’s ability to mentally construct meaning of their own environment and to create their own learning (Quay, 2003). According to Tam (2008) constructivists believe that all humans can construct knowledge in their own minds through a process of discovery and problem solving. This process aligns with Math 180’s focus which is to build understanding, reasoning, and communication skills during teacher lead instruction. Math 180 also provides scaffolded practice with routine and non-routine problems that promote problem solving and discovery learning by allowing students to build on concepts that students already understand, allowing students to construct meaning and create their own learning (Scholastic Corporation, 2014). Despite the goals of the Math 180 program the results revealed that the Math 180 program usage successful at predicting students' mathematical proficiency during the 2017 – 2018 school year but was not successful a predicting students' mathematical proficiency during the next two school years. Positively, the Math 180 program was not found to be more or less beneficial for the Black and Hispanic student groups when compared to their counterparts. Knowing that urban schools consist of primarily Black and Hispanic students and that those student groups showed similar results is an important consideration as Critical Race Theory (CRT) is also a theory that frames this research. CRT considers the role that race plays in educational opportunities, experiences, and outcomes. As it relates to this study it was important to determine if the outcomes were the same for various student groups, specifically racial groups.

Implications

Bloom identified mastery learning as an instructional practice that contributed to differences in academic achievement (Ungvarsky, 2020). The mastery learning approach provides a more individualized approach to learning by allowing students to repeat activities until they understand (Saveg-Sanchez &Rodriguez, 2020). Mastery learning was developed to support eliminating inequities in education and many other areas (Ungvarsky, 2020). Using computer-assisted instruction programs such as Math 180 supports the mastery learning approach. This is particularly important in urban schools where many students' mathematics proficiency is below grade level making remediation through intervention programs a viable option to closing gaps in student achievement. Title I funding allocated to urban schools makes purchasing intervention programs like Math 180 possible.

The first research question examines, “To what extent is the computer-assisted instruction program effective for improving mathematical proficiency?’ As an intervention program designed to help students progress toward their grade level curriculum, Math 180 should increase students’ mathematics proficiency (Scholastic Inc., 2013). However, the time spent using the Math 180 program has only proved to be effective in predicting mathematics proficiency in one of the three years analyzed in this study. During the 2017-2018 school year when the Math 180 program was effective in predicting mathematics proficiency the average time spent using the program was 1260 minutes. The data showed that during the subsequent 2018-2019 and 2019-2020 school year the average time decreased to 890 minutes and 910 minutes respectively. Therefore, the extent the program is effective may be different if implemented with fidelity. The extensive training that district’s teachers receive during initial implementation of a program is an important consideration as it relates to fidelity of implementation.

The second research question focused on determining if any significant differences exist between groups (Black, Hispanic, Students with Disabilities and English Learners) using the Math 180 program. For each of the years examined there was no significant difference between pretest and posttest scores. As expected, the groups were not equal in size because urban schools typically have a high population of Black students and Hispanic students. The groups of Students with Disabilities and English Learners were too small to be analyzed in this study. Different group sizes may have affected the outcome of the t-test although equal sample sizes is not an assumption of independent t-tests. The results imply that the Math 180 program was not more or less suited for Black and Hispanic student groups. There was a significant difference in students’ scores from the pretest to the posttest; however, the research was nonexperimental and did not include a control group. Therefore, increased mathematics proficiency could be attributed to other math instruction, teacher pedagogy or other implemented interventions not necessarily the Math 180 program.

Research question three asked how often Math 180 students experienced low growth, typical growth, and high growth on the Georgia Milestones End-of-Grade assessment. Student Growth Percentiles (SGPs) describe the amount of growth a student has demonstrated relative to a cohort of academically similar students across the state. 52 percent of students scoring at a rate greater than at least 35 percent of academically-similar students in mathematics during the 2017-2018 school year and 43 percent of students at a rate greater than at least 35 percent of academically-similar students in mathematics during the 2018 – 2019 school year implies that a significant number of students are demonstrating growth when compared to academically similar student across the state and narrowing the achievement gap in mathematics. SGPs can be used in addition to other information about student performance to improve student learning, instruction, and educational programs Department of Education (n.d).

By focusing on concepts and mathematical practices that prepare students for algebra Math 180 could be used by schools and districts to increase the mathematics achievement of struggling students. Through blended learning teacher effectiveness can be maximized using the Math 180 program, which provides consistent instruction that allow students to benefit from the opportunity to master skills and move forward at their own pace. The results of this study showed that increased usage of the program increases the likelihood of increasing mathematics achievement as desired.

Recommendations

There are several recommendations for further investigation based on the findings of this study. Recommendations for future research include a larger sample population so that the data can be generalized. This study only looked at eighth grade participants, but the Math 180 program is available for fifth to twelfth grade students. A truly randomized study with a control group is also recommended. The control group would inform the researcher if the lack of statistically significant gains by students were a result of the Math 180 program usage or if the results were due to other variables. A randomized study would also allow the research to plan for implementation rather than use secondary data obtained after implementation. Using three years of secondary data did allow for more insight; however, fidelity of implementation was not able to be monitored during this study. Monitoring the fidelity of implementation according to guidelines from the Scholastics Corporation would increase the validity of the findings. The training of teachers is also an important part of implementation and fidelity. Therefore, future research should also consider teacher training and coaching visits as a variable that could impact the effectiveness of the computer-assisted instruction program as it relates to increasing students' mathematics proficiency. When new programs are introduced to a district, teachers often receive the necessary training to effectively implement the program. Future research should consider if the level of training that is given during initial implementation of the program is maintained during subsequent years. This would ensure fidelity of implementation for teachers using the program for the first time and returning teachers as well. This study used pretest scores and total time using the Math 180 program as predictors to calculate multiple linear regression. There is additional information included in the Math 180 reports such as the number of topics completed which could be used as additional predictors in future research. Lastly, qualitative research could supplement the data in many ways such as exploring how individuals within urban Title I middle schools perceive they are impacted by the computer-assisted instruction program and how the program impacted the developed of a growth mindset.

Conclusion

The purpose of this study was to examine the effectiveness of a computer-assisted instruction mathematics intervention program, Math 180, at improving student mathematics achievement scores for eighth grade students enrolled in the program at urban Title I middle schools as measured by the Math Inventory assessment and Georgia Milestones End-Of-Grade assessment using secondary data obtained from the school district. The participants in this study were eighth grade students in urban Title I middle schools in the Stone Hill Public School district. The findings of this study shows that during the 2017-2018 school year, the first year of implementation in the SHPS district, Math 180 usage predict students' mathematics proficiency. However, during the next two school years program usage decreased and did not predict students' mathematical proficiency. The findings also show that the Math 180 program is not more or less beneficial for Black or Hispanic students at increasing mathematics proficiency. Even though Math 180 usage only predict students' mathematical proficiency during the 2017-2018 school year the findings showed that according to SGP some students who participated in the Math 180 program achieved at greater rater when compared to academically similar students across the state.

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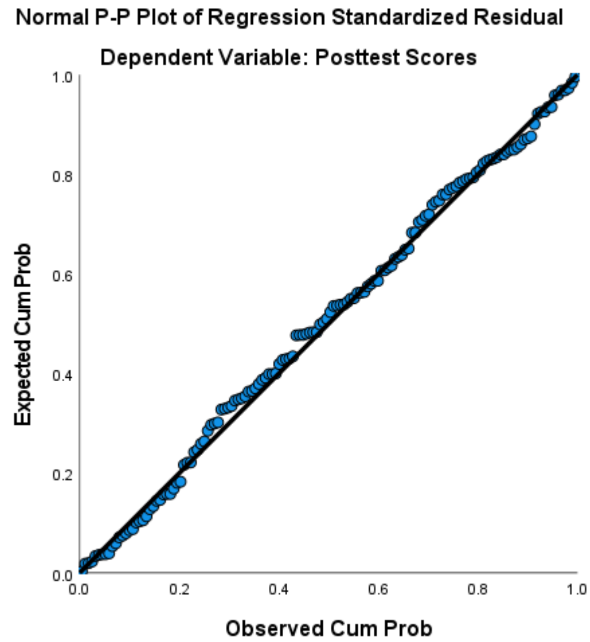
APPENDIXES

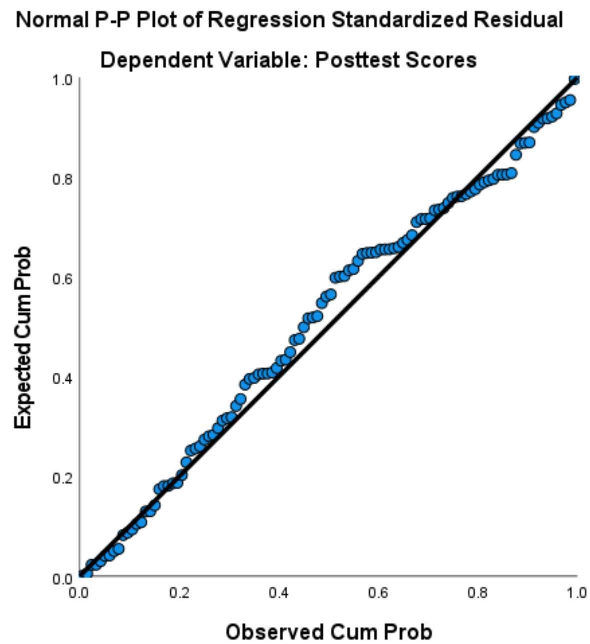
APPENDIX A

A Normal P-Plot

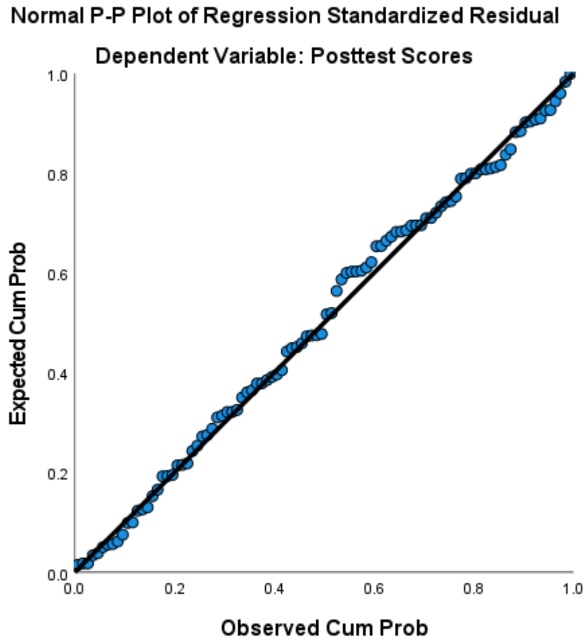
2017-2018 School Year



2018-2019 School Year



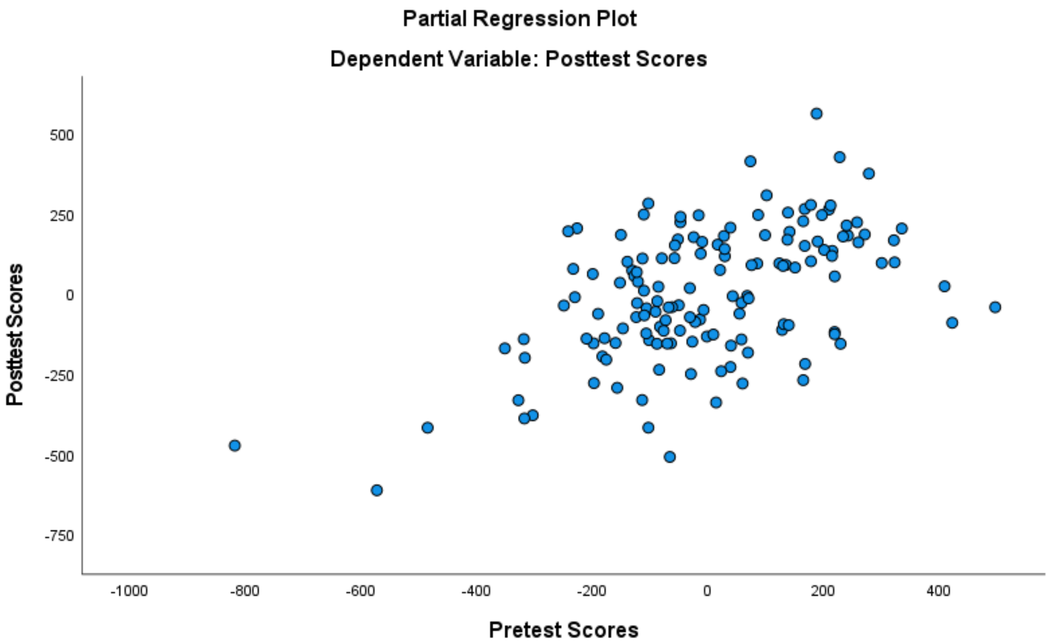
2019-2020 School Year



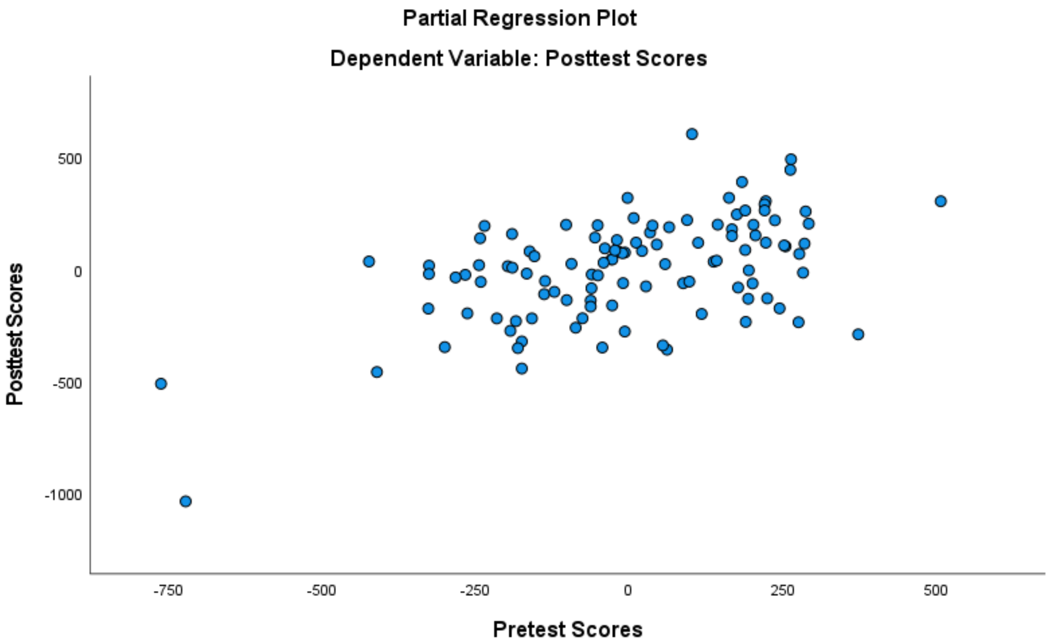
APPENDIX B

Scatterplot of Standardized Predicted Values

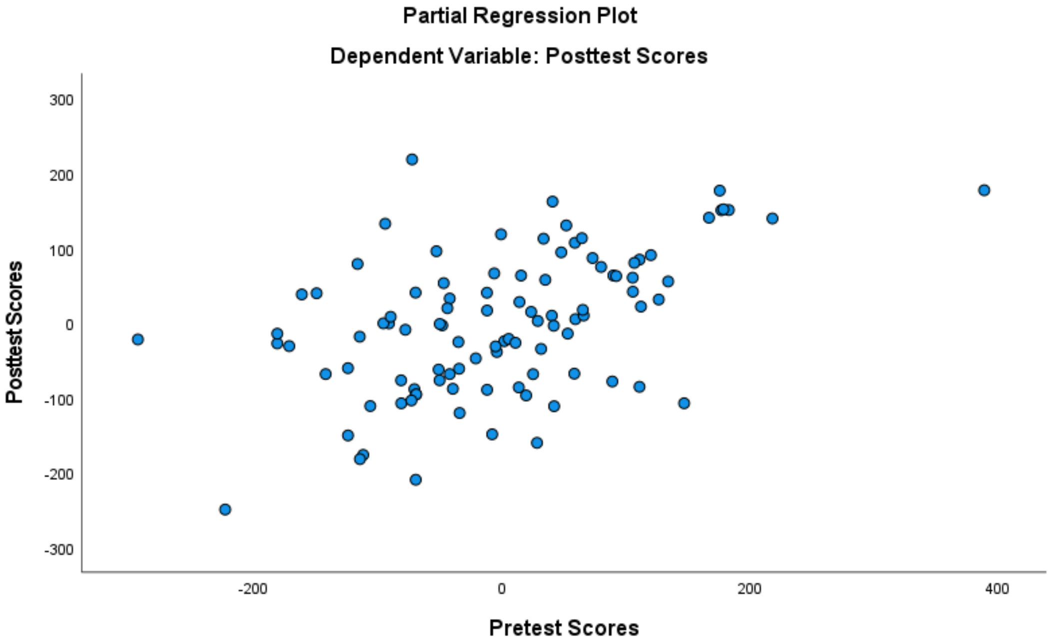
2017-2018 School Year



2018-2019 School Year



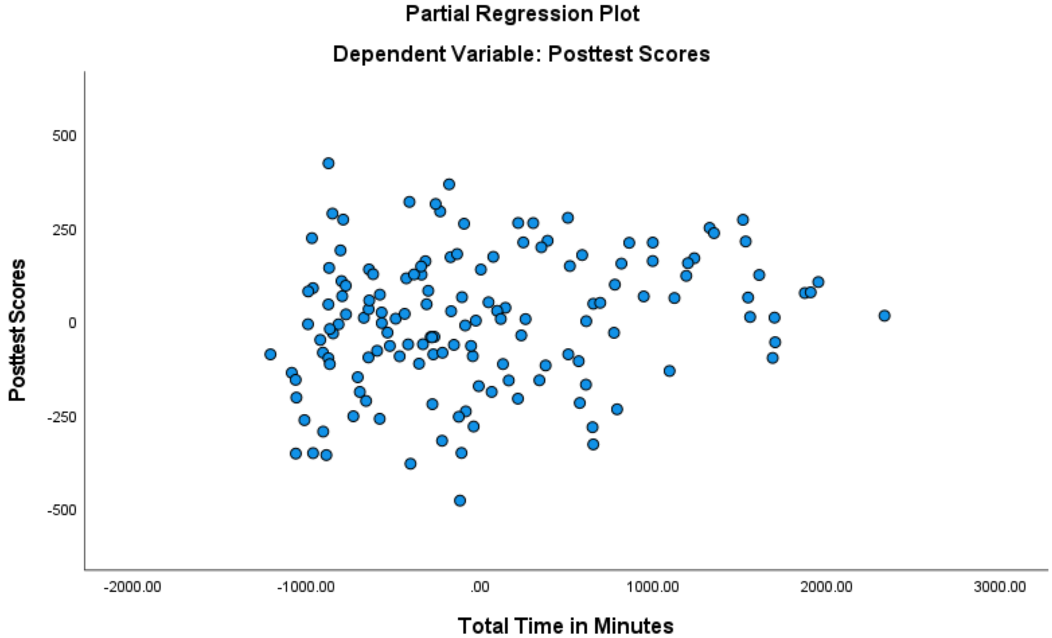
2019-2020 School Year



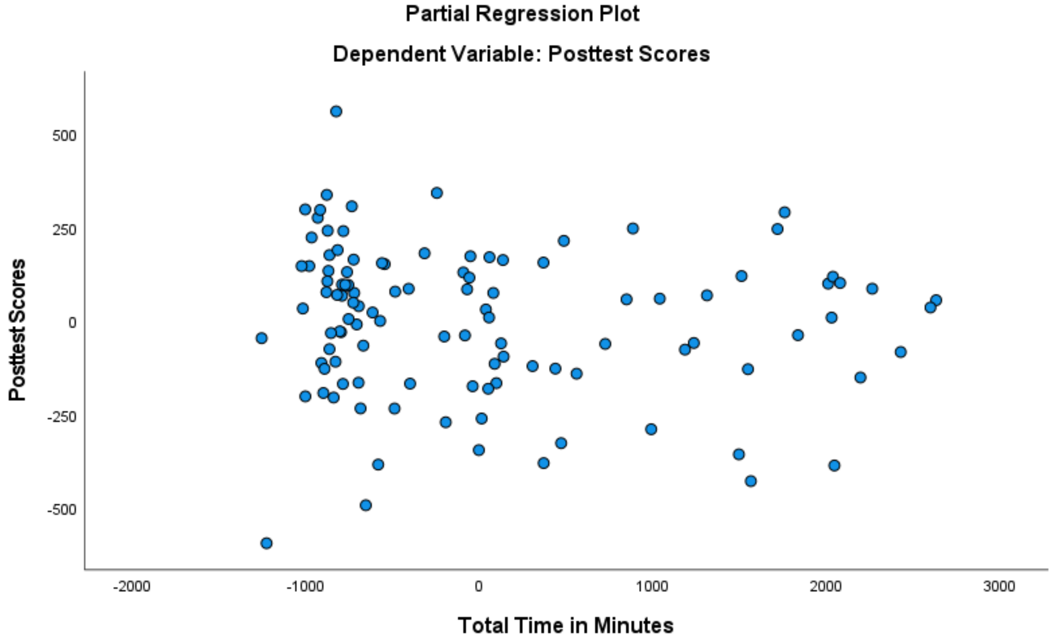
APPENDIX C

Scatterplot of Standardized Predicted Values

2017-2018 School Year



2018-2019 School Year



2019-2020 School Year