IMPACT OF EARLY CHILDHOOD EDUCATION ON LATER ACADEMIC ACHIEVEMENT

Amy Schmitz Weems, B.S., M.Ed.

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APPROVED:

David Brackett, Major Professor
Barbara Pazey, Committee Member
Frances van Tassell, Committee Member
Rick McDaniel, Committee Member
James D. Laney, Chair of the Department of Teacher Educator and Administration
Randy Bomer, Dean of the College of Education
Victor Prybutok, Dean of the Toulouse Graduate School

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The purpose of this study was to determine the effect of participation in the district's early childhood program on later academic achievement as measured by the State of Texas Assessment of Academic Readiness (STAAR) mathematics and reading assessments in Grades 3, 4, and 5. The studied district opened a centralized early childhood school in 2009 and implemented the Texas Pre-K Guidelines. The STAAR test results were available for five cohorts of students who attended the early childhood school and took the STAAR mathematics and reading assessments in the years 2014-2018. A quasi-experimental design was used to analyze differences in STAAR mathematics and reading scores for students who attended the district's early childhood program and students who did not attend. A two-way factorial ANOVA was used to examine the effect on test scores of attending the district's early childhood school and other demographic categories, Latinx, African American, socio-economic status, and English language learners (ELL). The results show that attending the early childhood program did not have a statistically significant effect for Latinx or African American students. However, the mean mathematics scores for economically-disadvantaged students who attended the early childhood program were higher than their peers who did not attend. ELL students who attended the program also had higher mathematics scores but the differences were usually not statistically significant. The same impact on economically-disadvantaged students and ELLs was not found on reading tests.

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CHAPTER 1

INTRODUCTION TO THE STUDY

Early childhood education holds promise for improving long-term educational outcomes. Reflecting this promise, enrollment rates in state-funded early childhood programs more than doubled between 2002 and 2016 (McCoy et al., 2017). As program enrollment increases, questions arise regarding whether early childhood education is fulfilling the promise of leveling the playing field for all students. As stated by Solano and Weyer (2017), "Achieving equity in early childhood education—making sure all children have the resources to be successful in school—is a fundamental goal" of all leaders in education (p. 1). Achieving this goal is a challenge as growing numbers of students live in poverty and speak languages other than English. Currently, one in four children under the age of 18 in the United States is Latinx (Bachman, Elliott, Scott, & Navarro, 2016). English language learners (ELLs) account for more than 15% of the student population in Texas (National Clearinghouse English Language Acquisition [NCELA], 2018). Thirty-eight percent of African American children live below the poverty line and are four times more likely to be poor than their White or Asian peers (Patten & Krogstad, 2015). African American children are at-risk for being unprepared for kindergarten at rates disproportionate to their White peers (Lee, Auty, & Williams, 2008; Lee & Bowen, 2006).

Despite the rising enrollment rates, early childhood program attendance rates are not as high in the United States as in other developed counties. Solano and Weyer (2017) found that almost 20% of U.S. children do not attend any form of preschool before entering kindergarten. Twenty-nine percent of high-income families enroll in preschool while only 19% of low-income families enroll in high-quality preschool programs. This can lead to children from low-income families, especially Latinx and African American children, entering kindergarten significantly

academically behind their White and high-income peers, resulting in an opportunity gap.

The opportunity gap refers to the diminished opportunity for some people to access quality resources, including high-quality education (Daniel, 2018). The opportunity gap for ELLs, Latinx students, African American students, and economically-disadvantaged students has led to wide differences on performance of academic achievement, compared to Whites (National Center for Educational Statistics, 2017). As accountability pressure mounts, policymakers increasingly promote school readiness to close this opportunity gap for minority students, students from poverty, and ELLs (Davis, Janus, Duku, & Gaskin, 2016). However, funding for pre-kindergarten (PK) and other early childhood programs is decreasing in states across the nation (Artz & Welsch, 2016). Texas policymakers seem torn on whether early childhood education and, specifically, high quality PK, is a good idea for Texas. In 2015, Governor Greg Abbott declared quality early childhood education to be one of his legislative priorities (Texas Education Agency [TEA], 2016). The Texas legislature subsequently passed House Bill 4 which provided $118 million in grants to local school districts and charter schools for expanding high-quality PK programs. The bill also added new reporting requirements about PK programs for all school districts. However, in the next legislative session, in 2017, state lawmakers stopped funding the grants for PK programs (Dugyala, 2018).

Texas developed the Texas Pre-Kindergarten Guidelines in 2008. These guidelines define "behaviors and skills that children are to exhibit and achieve, as well as instructional strategies for teachers" (TEA, 2015, p. 1). These guidelines align with the Texas Essential Knowledge and Skills (TEKS). The studied school district opened a centralized early childhood school in the fall of 2009. The district's early childhood education program implements the Texas Pre-Kindergarten Guidelines. The cohorts of students who attended the early childhood

school are now in grades where they take the State of Texas Assessment of Academic Readiness (STAAR). The district's early childhood school offers PK, Head Start, and the Preschool Program for Children with Disabilities (PPCD) for students under the age of five years. Enrollment requirements include that students must be an ELL or meet eligibility under the Individuals with Disabilities Education Act (IDEA) of 2004. Students also may enroll if they meet income eligibility guidelines, have a parent on active military duty, or are under the care of the Department of Family and Protective Services.

Statement of the Problem

The problem for this study was to identify whether children who attend an early childhood program achieve higher academic success. The school district of this study continues to see an opportunity gap on state assessments between their African American and Latinx students, compared to their White peers. A large opportunity gap exists for students who are economically disadvantaged and students who are ELLs, compared to the all-students passing rate on STAAR.

Table 1

District Passing Percentage on 2017-2018 STAAR Reading and Mathematics Assessments

		District Avg	AA	Latinx	White	ELL	EcoDis
Grade 3	Reading	82	72	72	92	67	68
	Mathematics	82	68	73	90	72	68
Grade 4	Reading	80	62	71	89	65	60
	Mathematics	84	67	79	91	65	60
Grade 5	Reading	87	76	79	95	73	73
	Mathematics	91	82	88	95	85	83

Source: Data retrieved from District's 2016-2017 Texas Academic Performance Report (TAPR) on the TEA website (ww.tea.state.tx.org)

The district's early childhood school serves approximately 500 students each year. The students who attend the district's early childhood school are almost 20% African American, almost 60% Latinx, and over 80% are economically-disadvantaged. The student population at the early childhood school is 50% ELL. Thus, there is a need to determine if the children who attend the district's early childhood school have higher academic achievement than their peers who do not attend. Table 1 shows the percentage of students passing the STAAR mathematics and reading assessments in Grades 3, 4, and 5 during the 2016-2017 school year.

Conceptual Framework

The conceptual framework for this study centers on the impact of early childhood education on later academic achievement. Students from various student groups (Latinx, African American, ELL, economically-disadvantaged) who attended the district's early childhood programs were compared to their peers who did not attend.

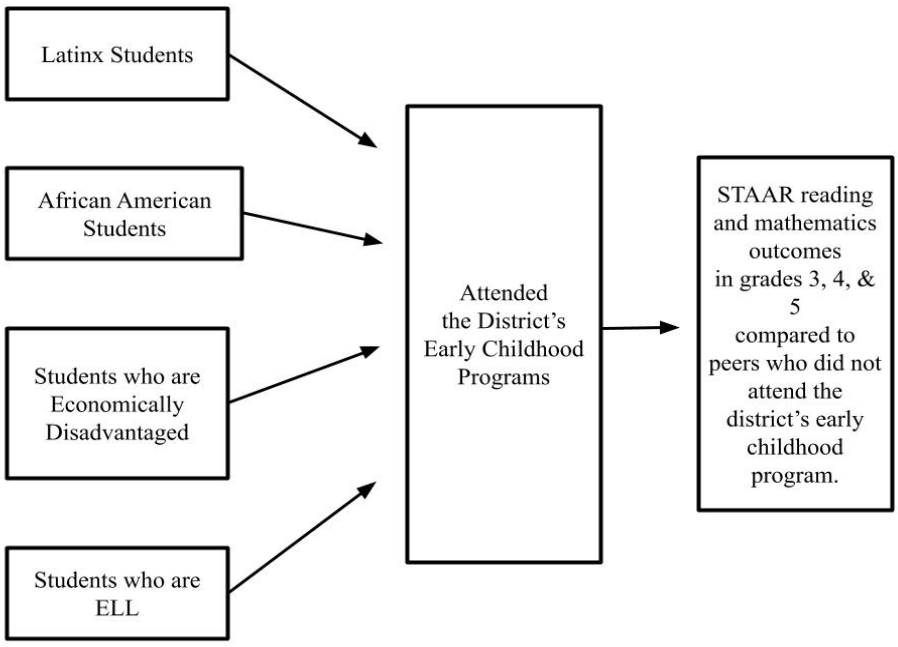

Figure 1. Conceptual framework. This framework depicts the relationship between attending the district's early childhood programs and STAAR reading and mathematics outcomes in Grades 3, 4, and 5.

Figure 1 demonstrates the relationship between participating in the district's early childhood program and later achievement on the state-mandated STAAR exams in reading and mathematics. The student demographic groups represent the majority of the students enrolled in the district's early childhood programs. These demographic groups are one of the independent variables in the study. Attending the district's early childhood program is the other independent variable. Students who did not attend the district's early childhood program were considered the control group. The dependent variable is the students' scores on the STAAR mathematics and reading assessments in Grades 3, 4, and 5.

Purpose of the Study

The purpose of this study was to determine the impact of participation in the district's early childhood program on later academic achievement. The findings of this study have the potential to influence early childhood education program designs regarding resource allocation and the number of students enrolled.

Research Question

I answered the following research question by analyzing the third-, fourth-, and fifth-grade STAAR test scores in mathematics and reading for students in one suburban north Texas school district. Through the study, I addressed the following research question: What is the effect of participation in early childhood education on mathematics and reading achievement, as determined by the achievement scores from STAAR exams in Grades 3, 4, and 5?

Significance of the Study

The significance of this study is rooted in the national focus on early childhood education and the particular focus on PK in Texas. "Understanding whether short-term gains of early

childhood programs persist, or whether they fade out over time, is of considerable interest to policymakers, educators, and parents who make decisions about funding and placement" (Hill, Gormley, & Adelstein, 2015, p. 60). School districts continue to see cuts to educational funding and policymakers at the state and local levels need to make decisions regarding early childhood programming. Results from this study could be used to inform policy-maker decisions about increasing funding for early childhood education programs. The results could also be used to inform decisions about increasing the number of students served in early childhood programs.

I sought to find valuable information regarding the long-term effects of early childhood education, using the Texas Pre-K Guidelines, especially among ELLs and students who are economically-disadvantaged. Results could show whether early childhood education is a viable avenue for helping to close the opportunity gap between Latinx and African American students and their White peers by providing a foundation that improves long-term academic achievement.

Delimitations

Delimitations clarify the scope and boundaries of a study (Roberts, 2010). For the current study, I utilized data from one suburban north Texas school district. The school district opened a centralized early childhood school in the fall of 2009. The data represent five cohorts of students that had an opportunity to attend the centralized program and subsequently took STAAR exams in Grades 3, 4, and 5. While this study is limited to one school district, the longitudinal data available contributes to the understanding of the impact of early childhood education on later academic achievement.

Assumptions

Some assumptions were made that are central to the design of the study. First, I assumed that parents correctly reported their child's race/ethnicity when enrolling in school and that the

school district followed appropriate procedures to identify students as ELL. Another assumption was that the database used for the study is a dependable and accurate source of student demographic data and assessment scores.

Definition of Key Terms

Definitions offer clarification and consistency in understanding. The following terms are defined as they apply to this study.

- Academic achievement. Academic achievement refers to student proficiency on grade-level appropriate competencies. There are numerous ways to measure academic achievement, but in this study, state standardized testing in mathematics and reading was identified.
- Early childhood education. Early childhood education encompasses the learning opportunities provided to children before the age of five and prior to elementary school enrollment (Curenton, Shen, & Dong, 2015; McCoy et al., 2017).
- Economically-disadvantaged. To qualify as economically-disadvantaged, students must qualify for free or reduced-price meals from the National School Lunch Program (United States Department of Agriculture [USDA], 2015). To qualify, families must have incomes at or below 185% of the federal poverty level.
- English language learner (ELL). According to the Texas Education Code, an English language learner is "a student whose primary language is other than English and whose English language skills are such that the student has difficulty performing ordinary classwork in English" (TEC § 29.052(1)). Identification is based on a home language survey completed by parents when a student enrolls in school, plus an English language proficiency test.

- Opportunity gap. Some students and families have diminished opportunity to access high-quality education programs. This diminished opportunity is a significant factor in performance gaps between racial/ethnic groups and socio-economic classes on achievement tests and other measures of academic success (Solano & Weyer, 2017).
- State of Texas Assessments of Academic Readiness (STAAR). The state of Texas implemented the STAAR assessment program in 2012 and it includes annual assessments for reading and mathematics for Grades 3-8 (Texas Education Agency [TEA], 2018). It is a criterion-referenced assessment designed to measure student understanding of the academic standards called the Texas Essential Knowledge and Skills (TEKS).

Organization of the Study

For this study, included in chapter one is an introduction to the study with an overview of the topic, significance of the study, the research questions, the conceptual framework, delimitations, assumptions, and definitions of terms. A comprehensive review of the literature surrounding the benefits of early childhood education, sustaining the gains of early childhood education, and the programs offered in the school district is provided in chapter two. The literature review concludes with an examination of the literature related to the conceptual framework in Figure 1. Chapter three focuses on the methodology utilized in answering the driving question of the study. Chapter four contains the results of the analyses that were completed for the study. The final chapter consists of a summary and discussion of the results, implications for practice, and recommendations for further research.

Summary

An opportunity gap persists between ELLs, Latinx students, African American students, economically-disadvantaged students, and their White peers. Increasing access to early

childhood programs could be a way to close the opportunity gap for ELLs, Latinx students, African American students, and students who are economically-disadvantaged. While early childhood education shows promise for helping close the opportunity gap, the question is whether students sustain the gains from early childhood education through the later elementary years. The purpose of this study was to determine if students who attended an early childhood education program have higher academic achievement in Grades 3, 4, and 5 than their peers who did not attend.

Chapter 2 is a review of the existing research surrounding the benefits of early childhood education and sustaining gains made in early childhood throughout later years. The literature review includes research on the specific impact of early childhood education on Latinx students, African American students, ELLs, and students who are economically disadvantaged.

CHAPTER 2

REVIEW OF LITERATURE

The purpose of this study was to examine the link between early childhood education programs and student academic outcomes, as measured by the State of Texas Assessments of Academic Readiness (STAAR) mathematics and reading assessments in one suburban Texas school district. The early childhood programs provided by a public-school district in Texas and the eligibility requirements of the programs were introduced in Chapter 1. I also outlined the opportunity gap seen within the school district between children from different socio-economic levels and different races/ethnicities. In this chapter, literature relevant to the benefits of early childhood education and the research on how to sustain the gains of early childhood education are reviewed. Also reviewed is literature that examined the specific design components of the early childhood programs, Head Start and pre-kindergarten (PK), both offered in the studied school district. Based on the conceptual framework from Chapter 1, included in this review of related literature is research regarding the specific impact of early childhood education on English language learners (ELLs), Latinx students, African American students, and students who are economically disadvantaged. Finally, examined in this review is the literature surrounding the STAAR mathematics and reading assessments.

Benefits of Early Childhood Education

Early childhood education programs hold promise for all students, but particularly for disadvantaged students (Faulkner & Coates, 2013; Gottfried & Kim, 2015; Gormley, Gayer, Phillips, & Dawson, 2008; Gormley & Phillips, 2005; Heckman, 2008; Magnuson, Ruhm & Waldfogel, 2007; Phillips, Gormley, & Anderson, 2016; Weiland & Yoshikawa, 2013; Wong, Cook, Barnett, & Jung, 2008). Programs with the most benefits focus on both cognitive skills

and non-cognitive skills, including motivation, focus on task, social skills, and self-regulation; the programs also provide family support (Heckman, 2008). Weiland and Yoshikawa (2013) found that students who participated in a PK program demonstrated statistically significant gains in mathematics, literacy, and language skills. These researchers also identified positive, but less significant, effects on impulse control, attention shifting, and positive emotions. The authors confirmed that students from poverty, determined by qualification for free or reduced lunch, benefit more from early childhood programs than their more affluent counterparts. Latinx, Asian, and Black students also seem to benefit more from program participation, when compared to their White counterparts. In a separate study by Gottfried and Kim (2015), the authors noted that children of immigrants, particularly those who speak Spanish as their home language, also benefit greatly from formal early childhood education programs. Program elements that lead to academic improvement and that produce positive effects on school readiness include evidence-based curricula delivered by college-educated teachers who have access to job-embedded instructional coaching (Weiland & Yoshikawa, 2013). Claessens and Engel (2013) suggested that early mathematic knowledge and skills are strong predictors of future success in mathematics and other academic areas. Helping children build their foundational skills in number recognition, pattern recognition, and measurement in PK programs could lead to increased mathematics scores as the child ages.

State-run PK programs in five states show positive short-term effects on the cognitive aspects of school readiness—vocabulary, pre-reading skills, and early mathematics skills (Wong et al., 2008). These state-run PK programs in New Jersey, Oklahoma, South Carolina, Michigan, and West Virginia had effect sizes of three times the federally-funded Head Start program in those states; however, the differences in the populations served by the respective programs in the

study clouded the comparison. Head Start guidelines require that 90% of the students come from families living at or below the poverty line, while the state programs were either universal, did not use poverty as a criterion, or accepted children from families living above the poverty line.

The benefits of early childhood education are evident in Tulsa, Oklahoma's public-schools' universal PK program, which is open to all four-year old students (Gormley & Phillips, 2005). The program had statistically significant positive effects on "children's performance on cognitive tests of prereading and reading skills, prewriting and spelling skill, and math reasoning and problem-solving abilities" (Gormley, Gayer, Phillips, & Dawson, 2008, p. 880). Tulsa's PK program benefitted all ethnic groups in the study—Latinx, African Americans, Native Americans, and Whites. Children from all income brackets also showed academic gains from the Tulsa PK program.

Faulkner and Coates (2013) examined practice and policy changes of early childhood over a 20-year period in England. They found that investment in state-run early childhood education was highly cost-effective, especially for children living in poverty. The authors made two key points about the economic impact of early childhood programs. First, children of poverty who are well-educated are less likely to participate in government welfare programs and are more likely to become employed as adults and contribute to the economy. Second, they found that parents of students participating in early childhood programs, particularly for single parent families, are able and more likely to return to the workforce and contribute to the economy because state-run early childhood programs provided affordable childcare.

There are important factors that lead to the economic benefits of early childhood programs. In Faulkner and Coates (2013) study, over the 20-year span of time, professional qualifications for staff developed as a need grew for high quality professionals in the field. The

need for a specific curriculum for the early childhood years also arose over time. Additionally, the authors pointed out the need to engage parents and educate them on early childhood development. Finally, it is important to maintain developmentally appropriate programs that utilize play, exploration, and creativity.

Gottfried and Kim (2015) examined the link between formal PK care and children's school readiness levels. They defined formal PK care as school-like childcare settings, including center-based care and Head Start, which have trained teachers and an overt focus on learning, compared to informal settings such as parent care, relative care, or a babysitter, which tend to be less structured and less focused on learning, and have untrained care providers. The programs for children from immigrant families showed a positive effect on academic and social-emotional school readiness measures if the children attended formal PK programs.

Sustaining Early Childhood Gains Long Term

Evaluations of early education programs show that most programs increase school readiness and pre-academic skills and can have lasting effects on children's later life outcomes (Duncan & Magnuson, 2013). A meta-analysis of early childhood education studies revealed that the academic impact of preschool programs faded out during elementary school, but students still demonstrated beneficial impacts on later-life outcomes, such as increased high school graduation rate, decreased teen parenthood, and decreased criminality.

There are various hypotheses regarding why the initial advantages of early childhood education seem to fade out. Hill, Gormley, and Adelstein's (2015) research in Tulsa's PK program showed that for one cohort, participation did not show statistically significant differences on Grade 3 tests, based on enrollment in PK, but another cohort showed that the PK program had a statistically significant impact on mathematics scores in Grade 3. The researchers

suggested that, in recent years, remediation services in elementary schools have improved and might be helping students who did not attend PK catch up to their peers who did. High quality learning experiences throughout elementary school can help sustain advantages gained from early childhood education (Heckman, 2008).

Some researchers found evidence that students were sustaining early childhood academic gains throughout the elementary school years and beyond. Curenton, Dong, and Shen (2015) found that students in Grade 5 who participated in PK or child care had stronger mathematics and reading skills than their non-enrolled peers. The researchers analyzed data from over 9,800 students in over 2,000 schools, using the Early Childhood Longitudinal Study, Kindergarten Cohort of 1998-1999 (ECLS-K); their sample included children who went to PK, Head Start, center-based care, and children who did not attend any early childhood program. Similarly, Vandell et al. (2010) found evidence that the quality of early child-care programs was a predictor of cognitive-academic achievement through the age of 15. This study tracked children who were economically and geographically diverse and showed positive effects for children from all socio-economic levels. The effect of early child-care quality on academic achievement maintained a similar effect size (.09-.12) from elementary school through the end of high school (Vandell, Burchinal, & Pierce, 2016). Phillips, Gormley, and Anderson (2016) found that Head Start participation resulted in higher mathematics scores in Grade 8, but only for Latinx students, White students, and students who qualified for free-lunch status. Attending Head Start can also lower the likelihood of retention in a grade prior to Grade 8 and decreases chronic absenteeism.

Andrews, Jargowsky, and Kune (2012) found statistically significant differences in Texas reading and mathematics scores of economically-disadvantaged and ELL students, compared to their peers who did not attend PK. The researchers analyzed Grade 3 mathematics and reading

data across the state of Texas, from over 650,000 students representing the racial/ethnic and socio-economic diversity of the state. This research relied on test data from students enrolled in kindergarten from 1994 to 1998. The purpose of the current study is to find out if these statistically significant differences persist in cohorts of students attending PK in one Texas school district after implementation of the Texas Pre-K Guidelines and taking the latest Texas academic achievement test, the STAAR.

Small-scale experiments in the 1960s and 1970s, such as the HighScope Perry Preschool Project and the Abecedarian Project, showed that early childhood education could foster long-term success, but the benefits of these programs have not been replicable on a large scale (Duncan & Magnuson, 2013). Both studies used participants who were disadvantaged children and followed them from preschool intervention through adulthood. The studies used different approaches, but both emphasized language development (Conti, Heckman, & Pinto, 2015).

HighScope Perry Preschool Project

The HighScope Perry Preschool Project followed 123 economically-disadvantaged African American children from preschool through age 40 (Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010). The Perry Preschool Project provided two years of half-day preschool from October through May each year (Conti, Heckman, & Pinto, 2015). Families received a weekly in-home visit. The program participants outperformed the control group on various tests from their preschool years through age 7 and on school achievement tests at ages 7, 8, 9, and 14 (Schweinhart, 2013). The program group also reported better attitudes toward school. The kindergarten through third grade teachers of children who had participated in the project reported fewer incidents of misconduct. Participation in the HighScope Perry Preschool Project improved early childhood intellectual performance as well as school motivation. Participant benefits

through age 40 included increased likelihood of graduating from high school, reduced criminal activity rates, and improved health (Conti et al., 2015; Heckman et al., 2010).

The Abecedarian Project

The Abecedarian project in North Carolina started in 1972 and enrolled children at birth (Conti et al., 2015). Participants received services for up to nine hours a day every weekday for 50 weeks a year. Some participants received only preschool intervention, some received only school-age intervention, and some received both preschool and school-age intervention through the first three years of elementary school (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002). The curriculum focused on language development through individualized games and interactions. The children also received health care and nutritional supplements. The Abecedarian participants earned higher test scores in mathematics and reading, attained more years of education, and were more likely to attend a four-year college. They were also healthier in their 30s than the control group (Conti et al., 2015).

The HighScope Perry Preschool Project and the Abecedarian Project both show that early childhood education can have long term impact on student outcomes. Both studies offered additional supports to students and families, in addition to preschool education. Many early childhood programs do not offer these additional supports to families. While these studies show the promise of early childhood education, the small sample sizes and uniqueness of the services offered made them difficult to replicate (Duncan & Magnuson, 2013).

Early Childhood Programs Offered in the Studied School District

The studied school district offers Head Start, PK, and the Preschool Program for Children with Disabilities (PPCD) programming for students under the age of five years. Each year, the district serves approximately 500 students in the early childhood programs. The district began

offering all early childhood programs in one centralized location during the 2009-2010 school year. The effect of this centralized early childhood program on cohorts of students' STAAR scores, as compared to their peers who did not attend the district's programs, is the focus of this study.

Head Start Program

Head Start is a federally funded national early childhood program. The eligibility guidelines require that at least 90% of the enrolled children live at or below the poverty line (Wong et al., 2008). The Head Start program does attempt to develop cognitive achievement but also "emphasizes health and nutrition programming, parental education and involvement, and coordination with social services" (p. 150). The program in the studied district offers full-day care (six hours), and both bilingual (Spanish and English) and monolingual (English only) classes are available. The classroom staff consists of one certified teacher with a college degree and one paraprofessional, with a maximum class size of 20 students. In addition to children living in poverty, Head Start also accepts a small percentage of children in foster care, children who are homeless, and children from families receiving public assistance.

Pre-Kindergarten Program

PK is a state-funded program for children who are under five years of age. Texas requires that students must be non-English speaking or limited English speaking and/or must meet income eligibility guidelines. In the studied district, PK classes offer half-day care (three hours). The class size maximum is 22 students with one teacher with a college degree and certification in early childhood, plus one paraprofessional.

Preschool Program for Children with Disabilities (PPCD)

PPCD is available for students who meet eligibility criteria under the Individuals with Disabilities Education Act (IDEA) (2004). This includes children identified with autism, learning disabilities, emotional disturbance, speech impairment, and orthopedic impairment (IDEA, 2004). PPCD classes are staffed with a certified special education teacher and a paraprofessional. In the studied district, the class sizes are small with less than 10 students in each class. The classes are half-day (three hours).

Conceptual Framework

Early childhood education shows promise for improving academic outcomes for students. The early childhood education programs in the studied district serve students who are English language learners (ELLs) and/or who meet income eligibility requirements. The majority of the participating students are Latinx or African American. The opportunity gap continues to exist for students identified as Latinx, African American, students on free or reduced lunch, and ELLs. The conceptual framework in Chapter 1 shows a potentially positive effect of attending the district's early childhood program on closing the opportunity gap on STAAR assessments in Grades 3, 4, and 5.

Latinx Students and Early Childhood Education

Latinx are the largest minority group within the United States, over 15% of the population, and account for 25% of school-age students (Gandara, 2017). There are many questions about whether the existing education system in the United States can adequately address the needs of this growing population. Latinx students continue to lag behind their White peers academically across the nation (Bachman et al., 2018; Reardon & Galindo, 2009). The enrollment of Latinx children in large-scale early childhood programs across the nation is

relatively low, with as many as 60% of Latinx children not attending preschool the year before they enter kindergarten (Ansari et al., 2017). Latinx children identified as English language learners (ELLs) and who attended public school PK are more likely to be successful on standardized tests in later grades than similar students who attended center-based care or no care at all because the students who attended public school PK had stronger English proficiency upon entering school (Ansari et al., 2017; Gottfried & Kim, 2015). Latinx students in Tulsa's PK program showed improvement in cognitive development and language skills (Gormley & Phillips, 2005). Early childhood programs show promise for improving the school readiness levels of Latinx children. School readiness levels for Latinx students can be a strong predictor of later academic outcomes (Quirk, Nylund-Gibson, & Furlong, 2013). These researchers used a scale that measured both social-emotional, behavioral and cognitive domains of school readiness, which were influenced by the child's age and preschool experience. Latinx students, who had attended a PK program, were more likely to score higher in school readiness ratings and have higher scores on Grade 2 achievement assessments.

African American Students and Early Childhood Education

The majority of participants in the Abecedarian Project and the Perry Preschool Project were African American children (Conti et al., 2015). These children showed statistically significant differences in education level and health, compared to the control group, decades after they received preschool intervention (Campbell et al, 2002; Conti et al, 2015; Heckman et al., 2010). In other studies, African American students showed gains in the Tulsa PK program, with cognitive development and language test scores improving by 17%, after controlling for other factors (Gormley & Phillips, 2005). However, these gains seemed to fade as the children aged, with no statistically significant associations found between Head Start participation and

academic achievement for African American students by Grade 8 (Phillips et al., 2016). There is still a need for more research to determine why African American students do not show the same gains from early childhood education as other races/ethnicities. Some believe socio-economic status causes this gap (Little, 2017; Phillips et al., 2016; Quinn, 2015).

Economically-Disadvantaged Students and Early Childhood Education

Economically-disadvantaged students come from families that are eligible for free or reduced-price meals from the National School Lunch Program (United States Department of Agriculture [USDA], 2015). Families must have an income level at or below 130% of the federal poverty guidelines of $25,100 annually for a family of four to receive free meals, or between 130-185% of the federal poverty level for reduced-price meals. PK programs benefit economically-disadvantaged students (Gormley & Phillips, 2005; Heckman, 2008; Magnuson et al., 2007; Weiland & Yoshikawa, 2013; Wong et al., 2008). Economically-disadvantaged students in Tulsa's PK program, saw "a 31% increase in cognitive skills, an 18% increase in language skills, and a 15% increase in motor skills" development through participation in the Tulsa PK program (Gormley & Phillips, 2005, p. 73). Hagans and Good (2013) noted that students from low income homes are more at-risk for developing persistent learning problems than their peers from mid- to high-income homes and that these persistent learning problems can have long-term detrimental outcomes. Their research found that economically-disadvantaged students exposed to a phonological awareness intervention had significant improvement in their phonological awareness and in other reading skills, compared to their peers who did not receive the intervention. While some states have universal PK programs, the programs in the studied district specifically target economically-disadvantaged students. Approximately 30% of students in the studied district are economically-disadvantaged.

English Language Learners and Early Childhood Education

According to the National Clearinghouse for English Language Acquisition (NCELA, 2018), ELLs account for more than 15% of the student population in Texas and the number continues to grow. This growing population is entering school systems at a time when state and federal accountability policies include a focus on the academic growth of ELLs (Cannon, Jacknowitz, & Painter 2011). Gottfried (2017) analyzed nationally representative data from the Early Childhood Longitudinal Study—Kindergarten to determine the influence of PK "care in the year before kindergarten entry on a range of socio-behavioral school readiness indicators measured at kindergarten entry" (p. 39). He determined that there was a positive influence on socio-behavioral outcomes for ELL students in non-parental care, either in childcare centers or non-center/non-parental settings. Non-ELL students had lower socio-behavioral outcomes if they attended center-based care. Improving students' socio-behavioral school readiness can lead to improved academic outcomes because students are able to use self-control, adapt to change, build relationships with teachers and peers, and express their feelings or opinions in positive ways. Childcare centers and non-parental-based care provide ELLs with opportunity to strengthen their English listening and speaking skills, as well as opportunities for vocabulary development. This opportunity is especially important for ELLs entering school settings where bilingual education in their native language is not available.

Other benefits of attending publicly-funded PK programs include a reduced rate of retention and enhanced English acquisition (Conger, Gibbs, Uchikoshi, & Winsler, 2019). These researchers found that ELL students who participated in the school's PK program exited from ELL status sooner than other students. Exiting ELL status is a sign of attaining language competence. PK programming provides ELL students with more exposure to English and can

build their oral language competence. Children who attain English oral language competence early also meet grade-level English reading expectations more quickly (Halle, Hair, Wandner, McNamara, & Chein, 2012). ELL students who are proficient in English by kindergarten kept pace with non-ELL peers in both reading and mathematics, but ELLs who were not proficient by Grade 1 had wider initial gaps in reading and mathematics achievement and these gaps continued over time.

State of Texas Assessment of Academic Readiness (STAAR)

Texas implemented the STAAR assessment program during the 2011-2012 school year (Texas Education Agency [TEA], 2018). Texas students take the tests annually in reading and mathematics in Grades 3-8. The assessment program is "designed to measure the extent to which students have learned and are able to apply the knowledge and skills defined in the state-mandated curriculum standards, the Texas Essential Knowledge and Skills (TEKS)" (p. 1). The STAAR is a one-day per subject multiple-choice test at the elementary level and the number of items on each test varies from year to year. The Human Resources Research Organization (HumRRO) analyzed the content validity, the reliability, and the test construction and scoring methods of the STAAR assessments in 2016. Content validity means that "items measure the content they were intended to measure" (Creswell & Creswell, 2018, p. 153). HumRRO found that test items aligned with the TEKS (HumRRO, 2016). TEA noted that "nationally established test development processes for the Texas assessment program are followed while developing the STAAR assessments in order to support the use of the STAAR scores in making inferences about students' knowledge and understanding of the TEKS" (TEA, 2016, p. 4-40). TEA formed item review committees of educators from across Texas to revise and edit test items, based on the TEKS.

An assessment is considered reliable when consistent results are found across multiple administrations of the test (Creswell & Creswell, 2018). HumRRO analyzed STAAR assessments and determined that the mathematics and reading assessments had high internal consistency reliability (HumRRO, 2016). TEA's own internal consistency studies estimated internal consistency at high levels across grades and content areas "with no noticeable increases or decreases across grades or content areas" (TEA, 2016, p.4-39). TEA also analyzed reliability using classical standard error of measurement, which "represents the amount of variance in a score that results from random factors other than what the assessment is intended to measure" (p. 4-39). The SEM values were between two to five raw score points in 2016. HumRRO (2016) determined that the STAAR assessments were reliable and the construction and scoring methods were "consistent with industry standards and…allow for the development of tests that yield valid and reliable assessment scores" (p. 58).

Summary

This literature review shows strong evidence for the benefits of preschool programs for students in various settings. How long the benefit of early childhood education lasts is questionable. Some studies found short-term benefits of early childhood education programs (Gormley et al., 2008; Gottfried & Kim, 2015; Weiland & Yoshikawa, 2013; Wong et al., 2008) while others show benefits lasting through upper elementary school, middle school, into the high school years and beyond (Andrews et al., 2012; Belfield et al., 2006; Curenton et al., 2015; Duncan & Magnuson, 2013; Phillips et al., 2016; Vandell et al., 2010, 2016). The literature seems to point to important gains for students identified as ELL, Latinx students, African American students, and economically disadvantaged students in some PK programs (Ansari et

al., 2017; Gormley & Phillips, 2005; Gottfried & Kim, 2015; Heckman, 2008; Magnuson et al., 2007; Phillips et al., 2015; Weiland & Yoshikawa, 2013; Wong et al., 2008).

The purpose of this study was to examine the effect of one suburban Texas school district's early childhood programs and the later outcomes for participants on the STAAR tests in Grades 3, 4, and 5. The studied district continues to see an opportunity gap between student groups, based on race/ethnicity and socioeconomic status. Understanding if the early childhood program has a positive impact on the scores of students identified as Latinx, African American, and/or economically disadvantaged students, compared to similar peers who did not attend the district's early childhood programs, could provide guidance to policy makers in the school district.

In Chapter 3, the research methodology used to investigate the effect of participation in an early childhood program on STAAR mathematics and reading scores. The research design, data collection strategies, and data analysis processes are explained.

CHAPTER 3

METHODOLOGY

Many early childhood programs show positive short-term effects for students (Wong et al., 2008). The HighScope Perry Preschool Project, Abecedarian Project, and studies of the Tulsa pre-Kindergarten (PK) programs show that the gains achieved in early childhood can lead to sustained academic success (Duncan & Magnuson, 2013; Heckman, 2008; Phillips, Gormley, & Anderson, 2016). The early childhood programs in Texas public schools serve students who speak languages other than English and those who live in poverty. Achievement gaps exist between Latinx students, African American students, students who are economically disadvantaged, English language learners (ELL) and their peers when students take standardized high stakes tests in Grades 3 through 12. Early childhood education holds promise for helping close these gaps by providing an even start at the beginning of school.

The purpose of this study was to determine the effect of participation in an early childhood program on mathematics and reading scores on the State of Texas Assessment of Academic Readiness (STAAR) in Grades 3, 4, and 5. This chapter includes the methodology and research design of the study, including participants, instrument, and the data analysis process. The following research question guided this examination: What is the effect of participation in early childhood education on mathematics and reading achievement, as determined by the achievement scores from STAAR exams, in Grades 3, 4, and 5?

Research Design

I used a quasi-experimental design for this quantitative study because I did not randomly assign group membership (Creswell & Creswell, 2018). Longitudinal STAAR data spanning five years permitted a quasi-experimental design, as outlined in Figure 2, in which participant

and non-participant students' scores were analyzed for differences in outcomes on the STAAR mathematics and reading tests.

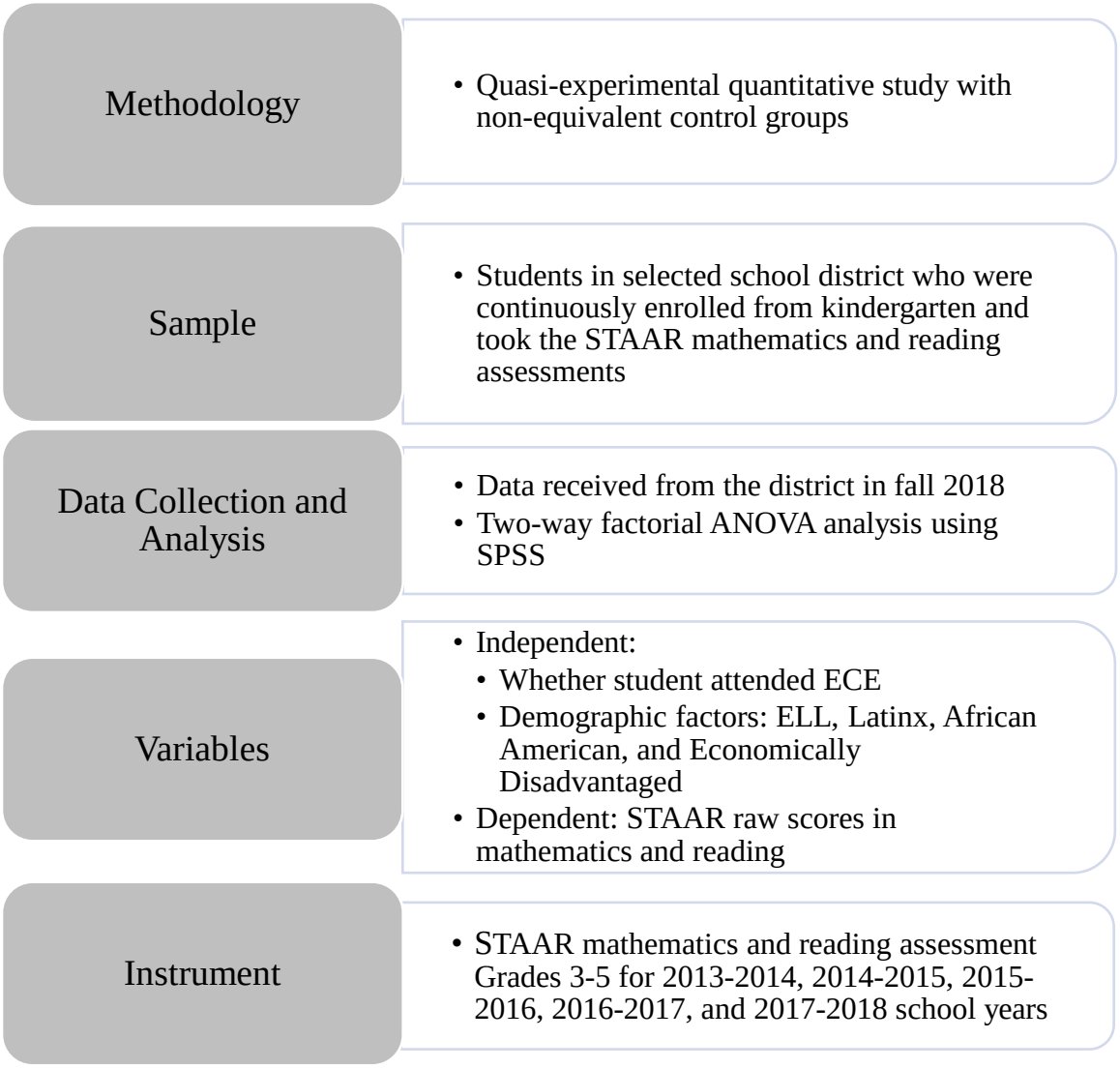

Figure 2. Research design. This visual shows the quasi-experimental research design with non-equivalent control groups to determine the effect of attending an early childhood education program on later achievement, as measured by STAAR mathematics and reading scores in Grades 3, 4, and 5.

I used a non-equivalent control group design because the number of students attending the early childhood school was lower than the number of students that did not attend (Campbell & Stanley, 1963).

Sample

The studied school district is in a suburban city in north central Texas. The district serves over 24,500 students in PK through 12th grade. The district demographics are 13% African American, 29% Latinx, and 50% White. About 30% of the district's students are economically disadvantaged and 11% have been identified as English language learners (ELL).

Context of the Studied School District

The district implemented the Texas Pre-K Guidelines and opened a centralized early childhood school in the fall of 2009. The school serves students under the age of five in Head Start, PK, and the Preschool Program for Children with Disabilities (PPCD). The district chose to centralize early childhood programs in order to have an age-specific and age-appropriate facility for young learners. Prior to centralization, the district distributed early childhood programs across various elementary school campuses and frequently moved programs due to space requirements. The elementary school classrooms and playgrounds were not designed for children under the age of five. Consolidating all programs in one building also allowed for more standardized curriculum and improved collaboration among early childhood teachers.

The STAAR test results were available for five cohorts of students who attended the early childhood school and took the STAAR reading and mathematics assessments in the 2013-2014, 2014-2015, 2015-2016, 2016-2017, and 2017-2018 school years. STAAR test results were examined for students who have been continuously enrolled in the school district from kindergarten through the testing year. Table 2 outlines the years that each cohort of students attended PK and took the STAAR mathematics and reading assessments.

Table 2

Cohorts by Grade and Enrollment Year, Tested and Not Tested

	Cohort 1	Cohort 2	Cohort 3	Cohort 4	Cohort 5	
PK/4	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	Not Tested
K	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	Not Tested
1	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	Not Tested
2	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	Not Tested
3	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	Grade 3 STAAR
4	2014-2015	2015-2016	2016-2017	2017-2018		Grade 4 STAAR
5	2015-2016	2016-2017	2017-2018			Grade 5 STAAR

Participation in the early childhood programs offered by the school district is voluntary. Students must be English language learners (ELL), identified with a disability, or meet income requirements in order to participate. The income requirements are determined by the federal government. The school district offers transportation to the early childhood programs. The control group of students did not participate in the district's early childhood education program but may have attended other forms of early childhood education, such as a private PK. The school district does not maintain data on students attending early childhood programs outside of the district.

I obtained school district permission to conduct this study in the fall of 2018. Following this approval, I received approval of the Institutional Review Board (IRB) at the University of North Texas in December of 2018. The IRB approval letter is in Appendix A.

Instrument

The sole instrument used for this study was the STAAR exam in mathematics and reading for Grades 3, 4, and 5. The Texas Education Agency (TEA) developed the STAAR

assessments and students test annually in mathematics and reading, starting in Grade 3. The state requires all Texas students in Grades 3 through 12 to participate in STAAR testing. The mathematics and reading tests in Grades 3-5 are one-day per subject multiple-choice format assessments.

The 2016 report by Human Resources Research Organization (HumRRO) supports that the STAAR assessments in Grades 3-8 are both reliable and valid. An assessment is considered reliable when consistent results are found across multiple administrations of the test (Creswell & Creswell, 2018). HumRRO analyzed STAAR assessments and determined that the mathematics and reading assessments had high internal consistency reliability (HumRRO, 2016). Validity refers to a test measuring what it is intended to measure. STAAR measures "the extent to which students have learned and are able to apply the knowledge and skills defined in the state mandated curriculum standards" (TEA, 2016, p. 1). HumRRO found that the test items had content validity, meaning that the "items measure the content they were intended to measure" (Creswell & Creswell, 2018, p. 153).

There is some concern about standardized test bias toward ELL students, Latinx students, African American students, and students who are economically disadvantaged. Test bias means that "characteristics of the test-taker, such as race, sex, family, wealth" influence the test score (Phillips, 2006, p. 52). Standardized tests can be culturally biased, reflecting the culture of those who designed the test, which creates a disadvantage for Latinx, African American, and economically-disadvantaged students (Phillips, 2006). Language proficiency also impacts student performance on standardized testing. The STAAR test is available in Grades 3-5 in Spanish and English. The test is not available in other languages for ELL students who do not speak Spanish.

Data Collection Plans

Data from the school district database in the state's Public Education Information Management System (PEIMS) can identify students who attended the district's early childhood programs. TEA uses PEIMS to monitor and manage data for all public-school districts in Texas. Officers of the school district provided the data from their PEIMS database and district testing files regarding whether a child attended the district's early childhood program, the child's demographic data, and raw scores on the STAAR mathematics and reading tests. All identifying factors, such as names or identification numbers, were masked prior to my receiving the data. Pseudo identification numbers were assigned to participants. The data retrieved from the district records supported a post hoc, non-intrusive examination of early childhood program effects (Creswell & Creswell, 2018).

Research Variables

The research design had two independent variables. The first independent variable was participation in the district's early childhood programs. The second independent variable was other demographic factors, such as race/ethnicity, socioeconomic status, or ELL status. The dependent variable was the student's raw score on the STAAR mathematics and reading tests in Grades 3, 4, or 5. The raw score represents the number of problems the student got correct on the test. The Texas Education Agency several times has adjusted the number of questions students need to answer correctly in order to meet the passing standard and the passing standard varies between subject areas and grade levels. Analyzing the raw score instead of passing rate allowed for comparison of how students performed on the test, regardless of changes in the state's passing standard from year to year. Student growth from year-to-year, as reported by STAAR, was not analyzed in the scope of this study.

Officers of the school district provided masked data in an Excel spreadsheet and I coded and uploaded the data to Statistical Package for the Social Sciences (SPSS). The data were coded 1 for attended the district's early childhood school and 0 for students who did not attend. I also coded the following demographic variables.

ELL

I coded ELL status as 1 for students identified as an ELL and 0 for not identified as an ELL. Parents complete a home language survey when they enroll students in a Texas public school. If a parent indicates that a student speaks a language other than English, the school district must test the student to determine if they qualify for ELL programs such as bilingual education or English as a Second Language (ESL) programming. This study included STAAR scores from ESL students and students participating in the district's bilingual education program. Students who had exited ELL status during elementary school were coded as ELL because they would have been eligible to attend the early childhood school for PK prior to exiting. I did not identify whether students tested in English or Spanish for this study.

Race/Ethnicity

The school district's PEIMS file contained race/ethnicity information for each student. PEIMS defines these racial/ethnic groups and parents choose their child's race/ethnicity identification upon enrollment in public school. Categories included Hispanic/Latinx, American-Indian/Alaska Native, Asian/Pacific Islander, African American, and White (National Center for Education Statistics [NCES], 1997). For the purposes of this study, students were coded as Latinx or not Latinx and African American or not African American. Other groups were not defined.

Socioeconomic Status

Socioeconomic status is determined as students who qualify for the National School Lunch Program, either through free or reduced-price lunches. The National School Lunch Program is a federally-funded meal program that provides eligible students with low-cost or free lunches (United States Department of Agriculture, 2015). Socioeconomic status was coded as a categorical variable, 1 for eligible for free or reduced-price lunches and 0 for non-participant.

Data Analysis Strategies

A two-way analysis of variance (ANOVA) examined the effect on test scores of attending the district's early childhood school and other demographic categories. I completed statistical calculations using the IBM SSPS software program. According to Mertler and Vannatta-Reinhart (2017), "factorial analysis of variance allows the researcher not only to test the significance of group differences," but also to determine if there are any interaction effects between the independent variables (p. 75). When a research design has two independent variables, it is important to evaluate the mean differences on the dependent variable produced by either Factor A independently or Factor B independently, or by Factor A and B in combination (Mertler & Vannatta-Reinhart, 2017). In this study, Factor A was whether a student attended the district's early childhood program. Factor B was a demographic category, such as ELL status, race/ethnicity, or socio-economic status. Interaction between factors was measured.

This research design was a variation of between-group design and used two treatment variables to assess the independent and simultaneous effects of the variables on the outcome (Vogt & Johnson, 2015). A statistically significant interaction shows how the effects of one independent variable differ according to levels of another independent variable (Mertler &

Vannatta-Reinhart, 2017). "Differences produced by either Factor A or Factor B, independent of the other, are called main effects" (Mertler & Vannatta-Reinhart, 2015, p. 75).

A factorial ANOVA was a preferable method to multiple regression for this study. Multiple regression determines which independent variables were predictors of a dependent variable. Factorial ANOVA compares differences and measures the interaction effect between the two independent variables and the dependent variable. A factorial ANOVA allowed for isolating variability in STAAR scores due to demographic factors, variability due to attending the studied district's early childhood program, and variability due to the interaction of demographic variables and attending the early childhood program.

I subjected the data to multiple 2 x 2 ANOVA on STAAR raw scores and attendance at the district's early childhood school by other demographic factors—race/ethnicity, ELL status, and socioeconomic status. Table 3 shows the combinations of demographic factors that I analyzed and the structure of the 2 x 2, two-factor design. No multiple comparisons tests were necessary since there are only two means for each group. Results with a higher mean showed that student performance on the assessment was better than a lower mean. I compared STAAR performance for each cohort of students separately from the performance of cohorts in subsequent years.

When a statistically significant interaction was found between factors, a one-way ANOVA was used to identify if the simple effect of attending the district's early childhood program was statistically significant for students in the demographic group. The simple effects analysis compares mean scores between members of the demographic group divided by whether the students attended the early childhood program.

Table 3

Structure of Two-Factor Design

	Early Childhood Program	
	Attended	Did Not Attend
ELL	STAAR score for *n* students	STAAR score for *n* students
Not ELL	STAAR score for n students	STAAR score for n student
Latinx	STAAR score for *n* students	STAAR score for *n* students
Not Latinx	STAAR score for n students	STAAR score for n student
African American	STAAR score for *n* students	STAAR score for *n* students
Not African American	STAAR score for n students	STAAR score for n student
Eco Dis*	STAAR score for *n* students	STAAR score for *n* students
Not Eco Dis	STAAR score for n students	STAAR score for n student

*Economically disadvantaged. A two-way ANOVA was used to investigate differences on STAAR scores for mathematics and reading, based on attending an early childhood school and demographic factors, ELL status, race/ethnicity, and economically disadvantaged status.

Limitations

Many different factors influence a child's academic progress. The focus of this study was the impact of early childhood education on academic achievement, as measured by STAAR. The scope of this study was limited to students who attended the district's centralized early childhood program, starting in 2009, and continued to attend school in the same district through Grades 3, 4, and 5. The population in some of the demographic groups is small. Due to the small sizes of some demographic groups, the results of this study might not be generalizable to the other districts. It is possible that students in the control group attended other early childhood programs, such as a private PK or a public-school early childhood program in another school district. The data for whether students attended a different early childhood program are unavailable at this time. Another limitation of this study was that some demographic categories

rely on parent response when completing registration forms. Parents must indicate that they speak another language on the initial home language survey for the district to identify students as an ELL. Parents self-identify race/ethnicity categories when registering their student for school. Also, parents must complete a form for their student to receive free or reduced-price lunch benefits. Another limitation of this study was that other factors might influence academic progress between the beginning of kindergarten and Grade 3. These other influences were not measured in this study.

Ethical Considerations

I considered protection of students throughout this study. The school district provided individual scores and demographic data with pseudo identification numbers to protect students' anonymity. The sample included all students in the cohorts who were continuously enrolled and participated in STAAR assessments in Grades 3-5 between the years of 2013-2018. I discussed the purpose, nature, and procedure of the research with the district's superintendent prior to the study, to assure the privacy and confidentiality of the student data and the district.

Summary

The purpose of this chapter is to review the study's methodology. I chose a quasi-experimental design with non-equivalent control groups to measure the impact of early childhood education on academic achievement, as measured by the STAAR mathematics and reading assessments in Grades 3, 4, and 5. I chose the school district through purposive sampling because the district implemented the Texas Pre-K Guidelines and opened a centralized early childhood program in 2009. I analyzed the data using a two-way ANOVA, which was well suited for this study to determine the impact of attending an early childhood program on STAAR scores in Grades 3, 4, and 5 for various groups of students. Understanding the impact of early

childhood education on later academic achievement may help school districts serve ELLs, Latinx students, African American students, and students who are economically disadvantaged. Improving educational opportunities for these student groups could help narrow the opportunity gap between these groups and their White peers. Chapter 4 contains the results of the analyses conducted.

CHAPTER 4

RESULTS

The purpose of this study was to determine the effect of participation in the studied district's early childhood program on later academic achievement, as measured by the STAAR mathematics and reading assessments in Grades 3, 4, and 5. Included in Chapter 4 are descriptive statistics and the statistically significant results of the two-way ANOVA organized by subject, mathematics or reading, and demographic factors, Latinx, African American, economically-disadvantaged and English language learners (ELL).

Research Question

I analyzed the third-, fourth-, and fifth-grade STAAR test scores in mathematics and reading to answer the following research question: What is the effect of participation in early childhood education on mathematics and reading achievement, as determined by the achievement scores from STAAR exams in Grades 3, 4, and 5?

Methodology

I used a quasi-experimental design with non-equivalent control groups to measure the impact of early childhood education on academic achievement, as measured by the STAAR mathematics and reading assessments in Grades 3, 4, and 5. A two-way factorial ANOVA was used to determine the impact of two independent variables on STAAR scores. The independent variables were attending the district's early childhood program, and a demographic factor, such as race/ethnicity, socioeconomic status, or ELL status. The effect sizes reported in this chapter are based on Cohen's (1988) guidelines of 0.02 is a small effect size, .13 is a medium effect size, and .26 is a large effect size. The two-way ANOVA results that show a statistically significant interaction are reported in this chapter by subject, then by demographic factor, then by year. I

included the data summary tables for ANOVA results that did not show a statistically significant interaction in Appendix C. When the two-way factorial ANOVA showed a statistically significant interaction between the independent variables, I conducted a one-way ANOVA to determine if the simple effect of attending the district's early childhood program was statistically significant for students in the demographic group and included the results.

Descriptive Statistics

The sample contained the demographic information and STAAR raw scores for students in cohorts participating in the STAAR mathematics and reading assessments in Grade 3 from 2014-2018, Grade 4 from 2015-2018, and Grade 5 from 2016-2018. These cohorts represent the students who had the opportunity to attend the district's centralized early childhood program and subsequently took the STAAR assessments. The descriptive statistics for each cohort by grade and test year are presented in Table 4.

Table 4

Descriptive Statistics of Grade 3-5 STAAR Mathematics and Reading Scores

Year	Mathematics			Reading		
	N	Mean	SD	N	Mean	SD
Grade 3						
2014	1755	33.78	9.062	1740	29.05	6.826
2015	1818	32.39	9.679	1817	28.08	7.732
2016	1811	33.34	9.597	1809	28.36	8.099
2017	1740	23.08	6.993	1740	24.02	7.399
2018	1778	22.46	7.128	1777	23.91	6.748
Grade 4						
2015	1837	31.81	9.986	1835	30.94	8.633250
2016	1831	33.18	9.836	1831	31.58	8.020
2017	1855	23.47	7.850	1857	24.98	7.576
2018	1787	24.22	7.233	1787	25.24	7.342

Year	Mathematics			Reading		
	N	Mean	SD	N	Mean	SD
Grade 5						
2016	1887	34.05	10.790	1885	33.65	8.968
2017	1878	25.71	7.467	1879	27.86	7.635
2018	1855	25.21	7.312	1851	27.91	7.425

The descriptive statistics for each independent variable were also analyzed. Tables 5, 6, 7, 8, 9, and 10 include the number of participants who attended the district's early childhood program and the number of students who did not attend, the mean STAAR raw score for each group, and the standard deviation for each group. Descriptive tables for other independent variables, race/ethnicity, socioeconomic status, and ELL status, can be found in Appendix B.

Table 5

Descriptive Statistics of Grade 3 STAAR Mathematics Scores by Independent Variable: Attending the District's Early Childhood Education Program

Year	Early Childhood Education Program					
	Attended			Did Not Attend		
	N	Mean	SD	N	Mean	SD
2014	243	31.82	9.153	1488	34.30	8.880
2015	320	28.04	10.079	1498	33.32	9.3336
2016	303	29.25	10.692	1506	34.17	9.150
2017	305	20.65	7.697	1433	23.60	6.718
2018	347	19.81	7.766	1430	23.10	6.815

Table 6

Descriptive Statistics of Grade 3 STAAR Reading Scores by Independent Variable: Attending the District's Early Childhood Education Program

Year	Early Childhood Education Program					
	Attended			Did Not Attend		
	N	Mean	SD	N	Mean	SD
2014	243	25.54	6.841	1488	29.68	6.601

Year	Early Childhood Education Program					
	Attended			Did Not Attend		
	N	Mean	SD	N	Mean	SD
2015	320	23.42	8.125	1497	29.07	7.270
2016	303	23.97	8.811	1506	29.24	7.653
2017	305	20.12	7.735	1433	24.85	7.061
2018	347	20.28	6.999	1430	24.79	6.384

Table 7

Descriptive Statistics of Grade 4 STAAR Mathematics Scores by Independent Variable: Attending the District's Early Childhood Education Program

Year	Early Childhood Education Program					
	Attended			Did Not Attend		
	N	Mean	SD	N	Mean	SD
2015	250	29.29	9.693	1584	32.19	9.982
2016	299	29.35	10.062	1529	33.95	9.606
2017	275	20.05	8.203	1577	24.06	7.637
2018	297	21.79	7.494	1489	24.71	7.084

Table 8

Descriptive Statistics of Grade 4 STAAR Reading Scores by Independent Variable: Attending the District's Early Childhood Education Program

Year	Early Childhood Education Program					
	Attended			Did Not Attend		
	N	Mean	SD	N	Mean	SD
2015	250	26.97	8.763	1584	31.57	8.448
2016	299	27.23	8.879	1529	32.44	7.557
2017	275	21.08	7.538	1577	25.69	7.353
2018	297	21.57	7.693	1489	25.98	7.050

Table 9

Descriptive Statistics of Grade 5 STAAR Mathematics Scores by Independent Variable: Attending the District's Early Childhood Education Program

Year	Early Childhood Education Program					
	Attended			Did Not Attend		
	N	Mean	SD	N	Mean	SD
2016	245	30.99	10.778	1637	34.52	10.720
2017	287	22.75	7.648	1594	26.24	7.310
2018	262	21.33	7.759	1587	25.70	7.127

Table 10

Descriptive Statistics of Grade 5 STAAR Reading Scores by Independent Variable: Attending the District's Early Childhood Education Program

Year	Early Childhood Education Program					
	Attended			Did Not Attend		
	N	Mean	SD	N	Mean	SD
2016	245	29.27	9.116	1637	34.30	8.766
2017	287	23.51	8.027	1594	28.64	7.299
2018	262	24.18	7.911	1587	28.53	7.160

Statistically Significant Results for Mathematics

Latinx Students

A two-way ANOVA was conducted that examined the effect of attending the district's early childhood program and being a Latinx student on Grade 3 STAAR mathematics scores. There were no statistically significant interactions between attending the district's early childhood program and Latinx for the cohorts in Grade 3 in 2014, 2015, 2016, or 2017.

ANOVA results, summarized in Table 11, show a statistically significant interaction between factors on the 2018 Grade 3 mathematics STAAR [$F(1, 1774) = 8.528$, $p = .004$, partial $\eta^2 = .005$]. The effect size estimate is very small. The simple effect analysis, presented in Table

12, showed that there were not statistically significant differences in mean scores for Latinx students attending the early childhood program and Latinx students not participating [$F(1, 576) = 3.596$, $p = .058$, partial $\eta^2 = .006$], but the simple effect for students who are not Latinx showed statistically significant higher scores independent of attending the early childhood program [$F(1, 1198) = 35.681$, $p < .001$, partial $\eta^2 = .029$]. The effect size estimate is small.

Table 11

Two-way ANOVA Summary Table for Grade 3 Mathematics 2018: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
Latinx	12.527	1	<.001	.007
ECE	31.807	1	<.001	.018
Latinx*ECE	8.528	1, 1774	.004	.005

Table 12

Simple Effect of Attending Early Childhood Program on Students' Grade 3 Mathematics 2018 Scores for Independent Variable: Latinx

	F	df	Sig.	ES
Latinx	3.596	1, 576	.058	.006
Not Latinx	35.681	1, 1198	<.001	.029

I conducted a two-way ANOVA examining the effects of attending the district's early childhood program and Latinx on Grade 4 STAAR mathematics scores. No statistically significant interactions between factors were found on the Grade 4 STAAR mathematics assessment in 2015, 2016, 2017, or 2018.

The results of a two-way ANOVA examining the effects of attending the district's early childhood program and Latinx on Grade 5 STAAR mathematics scores are displayed in Table

13. ANOVA results show a statistically significant interaction between factors [F(1, 1883) = 5.498, p = .019, partial η^2= .003]. The calculated effect size estimate indicates a very small effect size for the interaction. Simple effects analysis, presented in Table 14, showed that Latinx students who attended the early childhood program scored higher than the Latinx students who did not attend but the differences in mean Latinx scores were not statistically significant [F(1, 516) = .005, p = .946, partial η^2 = .000]. The simple effect analysis for non-Latinx students show that they had statistically significant higher scores independent of attending the early childhood program.

Table 13

Two-way ANOVA Summary Table for Grade 5 Mathematics 2016: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
Latinx	15.508	1	<.001	.008
ECE	5.100	1	.024	.003
Latinx*ECE	5.498	1, 1883	.019	.003

Table 14

Simple Effect of Attending Early Childhood Program on Students' Grade 5 Mathematics Scores for Independent Variable: Latinx

	F	df	Sig.	ES
Latinx	.005	1, 516	.946	.000
Not Latinx	8.760	1, 1367	.003	.006

African American Students

I conducted a two-way ANOVA that examined the effect of attending the district's early childhood program and being African American on the STAAR mathematics assessments raw

scores in Grades 3, 4, and 5. There were no statistically significant interactions found on any of the STAAR mathematics assessments in Grades 3, 4, and 5 for African American students. The data tables are summarized in Appendix C.

Students who are Economically Disadvantaged

I used a two-way ANOVA to examine the interaction between the factors of attending the district's early childhood program and students who are economically disadvantaged on the Grades 3, 4, and 5 STAAR mathematics assessments. ANOVA results, presented in Table 15, show a statistically significant interaction between the effects of attending the early childhood program and being economically disadvantaged on the Grade 3 mathematics assessment in 2014 [$F(1, 1751) = 4.607$, $p = .032$, partial $\eta^2 = .003$,], in 2017 [$F(1, 1736) = 11.160$, $p = .001$, partial $\eta^2 = .006$], and in 2018, [$F(1, 1774) = 18.973$, $p < .001$, partial $\eta^2 = .011$].

Table 15

Two-way ANOVA Summary Table for Grade 3 Mathematics: Economically-Disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
2014				
Economically Disadvantaged	67.939	1	<.001	.003
ECE	0.263	1	.686	.000
Economically Disadvantaged *ECE	4.607	1, 1751	.032	.003
2017				
Economically Disadvantaged	63.187	1	<.001	.035
ECE	6.229	1	.013	.004
Economically Disadvantaged *ECE	11.160	1, 1736	.001	.006
2018				
Economically Disadvantaged	71.743	1	<.001	.039
ECE	14.743	1	<.001	.008
Economically Disadvantaged *ECE	18.973	1, 1774	<.001	.011

Simple effect analysis of attending the early childhood program for economically disadvantaged students is displayed in Table 16. Economically-disadvantaged students who tested in 2014 and attended the district's early childhood program had a statistically significant higher mean score than students who are economically disadvantaged and did not attend the district's program [$F(1, 586) = 4.270$, $p = .039$, partial $\eta^2 = .007$]. The effect size estimate is small. Economically-disadvantaged students who attended the early childhood program scored higher on average in 2017 and 2018 than their economically-disadvantaged peers who did not attend but the differences in the mean scores were not statistically significant. Students who are not economically disadvantaged had higher mean scores independent of placement in the district's early childhood program. The mean differences were statistically significant between students who are not economically disadvantaged independent of attending the early childhood program in 2017 [$F(1, 1150) = 16.195$, $p < .001$, partial $\eta^2 = .014$], and 2018 [$F(1, 1107) = 31.105$, $p < .001$, partial $\eta^2 = .027$]. The estimate of effect size was small for both years.

Table 16

Simple Effect of Attending Early Childhood Program on Students' Grade 3 Mathematics Scores for Independent Variable: Economically-Disadvantaged

	F	df	Sig.	ES
2014				
Economically Disadvantaged	4.270	1, 586	.039	.007
Not Economically Disadvantaged	1.261	1, 1165	.262	.001
2017				
Economically Disadvantaged	.370	1, 586	.543	.001
Not Economically Disadvantaged	16.195	1, 1150	<.001	.014
2018				
Economically Disadvantaged	.147	1, 667	.702	.000
Not Economically Disadvantaged	31.105	1, 1107	<.001	.027

A two-way ANOVA was conducted to investigate the interaction between attending the early childhood program and economically disadvantaged students on the Grade 4 STAAR mathematics assessment. Results, shown in Table 17, show a statistically significant interaction between factors in 2015 [F(1, 1833) = 5.314, p = .021, partial η^2 = .003], 2016 [F(1 ,1827) = 4.590, p = .032, partial η^2 = .003], and 2018 [F(1, 1783) = 8.075, p = .005, partial η^2 = .005]. The effect size estimates for all three years show that the effect size was very small. There was not a statistically significant interaction on Grade 4 STAAR mathematics raw scores for students who were economically disadvantaged in 2017.

Table 17

Two-way ANOVA Summary Table for Grade 4 Mathematics: Economically-Disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
Economically Disadvantaged	77.480	1	<.001	.041
ECE	.259	1	.611	.000
Economically Disadvantaged *ECE	5.314	1, 1833	.021	.003
2016				
Economically Disadvantaged	107.001	1	<.001	.055
ECE	3.290	1	.070	.002
Economically Disadvantaged *ECE	4.590	1, 1827	.032	.003
2018				
Economically Disadvantaged	91.584	1	<.001	.049
ECE	2.245	1	.134	.001
Economically Disadvantaged *ECE	8.075	1, 1783	.005	.005

The simple effect for economically disadvantaged students of attending the district's early childhood program is displayed in Table 18. The simple effect of attending the district's early childhood program was statistically significant for economically-disadvantaged students in

2015 [F(1, 602) = 5.640, p = .018, partial η^2 = .009]. The calculated estimate of effect size is very small. The mean score of students who are economically disadvantaged and attended the district's early childhood program was higher than their economically-disadvantaged peers who did not attend in 2015, 2016, and 2018; however, the simple effect analysis showed the differences in mean scores in 2016 and 2018 were not statistically significant. Students who are not economically disadvantaged scored higher then economically-disadvantaged students, regardless of whether or not they attended the early childhood program.

Table 18

Simple Effect of Attending Early Childhood Program on Students' Grade 4 Mathematics Scores for Independent Variable: Economically-Disadvantaged

	F	df	Sig.	ES
2015				
Economically Disadvantaged	5.640	1, 602	.018	.009
Not Economically Disadvantaged	1.260	1, 1231	.262	.001
2016				
Economically Disadvantaged	1.177	1, 631	.278	.002
Not Economically Disadvantaged	1.505	1, 1176	.220	.001
2018				
Economically Disadvantaged	1.058	1, 620	.304	.002
Not Economically Disadvantaged	8.300	1, 1162	.004	.007

The ANOVA results for Grade 5 STAAR mathematics in 2016 are displayed in Table 19 and show a statistically significant interaction between the factors of attending the district's early childhood program and students who are economically disadvantaged [F(1, 1883), p = .046, partial η^2 = .002]. The effect size estimate was small. The simple effect of attending the early childhood program on students who are economically disadvantaged was not significant [F(1, 635) = 2.615, p = .106, partial η^2 = .004]. The difference in the mean scores of economically

disadvantaged students was not significantly impacted by their attendance at the early childhood program, as the mean differences between economically disadvantaged students who attended and those who did not were very small. Students who were not economically disadvantaged scored higher on the STAAR mathematics test independently of their attendance at the district's early childhood program [$F(1, 1248) = 1.680$, $p = .195$, partial $\eta^2 = .001$]. The results of the ANOVA to test simple effects are displayed in Table 20. There were no statistically significant interactions on Grade 5 STAAR mathematics in 2017 or 2018 for students who are economically-disadvantaged.

Table 19

Two-way ANOVA Summary Table for Grade 5 Mathematics 2016: Economically-Disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
Economically Disadvantaged	80.044	1	<.001	.041
ECE	.004	1	.949	.000
Economically Disadvantaged *ECE	3.979	1, 1883	.046	.002

Table 20

Simple Effect of Attending Early Childhood Program on Students' Grade 5 Mathematics 2016 Scores for Independent Variable: Economically-Disadvantaged

	F	df	Sig.	ES
Economically Disadvantaged	2.615	1, 635	.106	.004
Not Economically Disadvantaged	1.680	1, 1248	.195	.001

English Language Learners

A two-way ANOVA was used to examine the effect of attending the district's early childhood program for students who are ELL. There was a statistically significant interaction for

every cohort in Grades 3, 4, and 5 in all years in the data sample.

The Grade 3 results are summarized in Table 21. The interactions between factors were statistically significant with small effect size estimates in 2014 [$F(1, 1751) = 11.039$, $p = .001$, partial $\eta^2 = .006$], 2015 [$F(1, 18140) = 19.258$, $p < .001$, partial $\eta^2 = .011$], 2016 [$F(1, 1807) = 5.290$, $p < .001$, partial $\eta^2 = .013$], and 2018 [$F(1, 1774) = 29.697$, $p < .001$, partial $\eta^2 = .016$]. While the ELL students who attended the early childhood program scored higher than their ELL peers who did not participate, the simple effects analysis shows that the differences between means for the groups were not statistically significant.

Table 21

Two-way ANOVA Summary Table for Grade 3 Mathematics: ELL Status and Early Childhood Education (ECE)

	F	df	Sig.	ES
2014				
ELL	7.926	1	.005	.005
ECE	1.591	1	.207	.001
ELL*ECE	11.039	1, 1751	.001	.006
2015				
ELL	18.069	1	<.001	.010
ECE	17.414	1	<.001	.010
ELL*ECE	19.258	1, 1814	<.001	.011
2016				
ELL	18.607	1	<.001	.010
ECE	11.584	1	.001	.006
ELL*ECE	24.011	1, 1807	<.001	.013
2017				
ELL	0.382	1	.537	.000
ECE	23.023	1	<.001	.013
ELL*ECE	5.290	1, 1736	.022	.003

	F	df	Sig.	ES
2018				
ELL	2.852	1	.091	.002
ECE	19.365	1	<.001	.011
ELL*ECE	29.697	1, 1774	<.001	.016

In 2017, the interaction between attending the early childhood program and ELL status was statistically significant [$F(1, 1736) = 5.290$, $p = .022$, partial $\eta^2 = .003$]. ELL students who attended the district's early childhood program scored higher on average than other non-ELL students who participated. The ELL students who attended had a lower mean score than other ELL students in the district who did not participate in the early childhood program. The simple effects analysis in Table 22 shows that the differences in mean scores for ELL students participating in the district's early childhood program and their ELL peers who did not attend were not statistically significant [$F(1, 312) = 2.259$, $p = .134$, partial $\eta^2 = .007$].

Table 22

Simple Effect of Attending Early Childhood Program on Students' Grade 3 Mathematics Scores for Independent Variable: ELL Status

	F	df	Sig.	ES
2014				
ELL	1.912	1, 312	.168	.006
Not ELL	10.984	1, 1439	.001	.008
2015				
ELL	.017	1, 320	.898	.000
Not ELL	47.799	1, 1494	<.001	.031
2016				
ELL	.807	1, 310	.370	.003
Not ELL	44.397	1, 1497	<.001	.029

	F	df	Sig.	ES
2017				
ELL	2.259	1, 312	.134	.007
Not ELL	32.026	1, 1424	<.001	.022
2018				
ELL	.414	1, 360	.520	.001
Not ELL	62.229	1, 1414	<.001	.042

I summarized the results of the ANOVA for Grade 4 mathematics in Table 23. The interaction between factors was statistically significant in 2015 [$F(1, 1833) = 16.835$, $p < .001$, partial $\eta^2 = .009$], 2016 [$F(1, 1827) = 18.244$, $p < .001$, partial $\eta^2 = .010$], 2017 [$F(1, 1851) = 28.131$, $p < .001$, partial $\eta^2 = .015$], and 2018 [$F(1, 1783) = 5.381$, $p = .020$, partial $\eta^2 = .003$]. The effect size estimates were small.

ELL students who attended the district's early childhood program had higher average scores on all Grade 4 mathematics tests than their ELL peers who did not attend. The mean differences were only statistically significant in 2015 [$F(1, 326) = 6.027$, $p = .015$, partial $\eta^2 = .018$]. The simple effect analysis results are summarized in Table 24. ELLs who attended the early childhood program had higher average scores than their non-ELL peers who attended the early childhood program. Non-ELL students who did not attend the early childhood program had higher average scores than those who did attend.

Table 23

Two-way ANOVA Summary Table for Grade 4 Mathematics: ELL Status and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
ELL	16.210	1	<.001	.009
ECE	.389	1	.533	.000

	F	df	Sig.	ES
ELL*ECE	16.835	1, 1833	<.001	.009
2016				
ELL	14.074	1	<.001	.008
ECE	10.926	1	.001	.006
ELL*ECE	18.244	1, 1827	<.001	.010
2017				
ELL	14.661	1	<.001	.008
ECE	11.462	1	.001	.006
ELL*ECE	28.131	1, 1851	<.001	.015
2018				
ELL	2.776	1	.096	.002
ECE	16.162	1	<.001	.009
ELL*ECE	5.381	1, 1783	.020	.003

Table 24

Simple Effect of Attending Early Childhood Program on Students' Grade 4 Mathematics Scores for Independent Variable: ELL Status

	F	df	Sig.	ES
2015				
ELL	6.027	1, 326	.015	.018
Not ELL	11.229	1, 1507	.001	.007
2016				
ELL	.359	1, 325	.549	.001
Not ELL	34.546	1, 1502	<.001	.022
2017				
ELL	1.042	1, 319	.228	.005
Not ELL	44.043	1, 1502	<.001	.028
2018				
ELL	1.092	1, 319	.297	.003
Not ELL	24.743	1, 1541	<.001	.028

Grade 5 results showed statistically significant interactions between the factors of ELL status and attending the early childhood program on the STAAR mathematics assessments in all three years examined. The interaction between factors was statistically significant in 2016 [F(1, 1883) = 9.614, p =.002, partial η^2 = .005], in 2017 [F(1, 1874) = 6.589, p = .010, partial η^2 = .004], and in 2018 [F(1, 18510 = 17.105, p < .001, partial η^2 = .009]. There is a summary of the two-way ANOVA for Grade 5 mathematics in Table 25.

Table 25

Two-way ANOVA Summary Table for Grade 5 Mathematics: ELL Status and Early Childhood Education (ECE)

	F	df	Sig.	ES
2016				
ELL	20.351	1	<.001	.011
ECE	1.433	1	.231	.001
ELL*ECE	9.614	1, 1883	.002	.005
2017				
ELL	32.319	1	<.001	.017
ECE	6.957	1	.008	.004
ELL*ECE	6.589	1, 1874	.010	.004
2018				
ELL	17.991	1	<.001	.010
ECE	7.830	1	.005	.004
ELL*ECE	17.105	1, 1851	<.001	.009

The simple effect of attending the early childhood program for ELL students was examined with an ANOVA. ELL students who attended the early childhood program had higher mean scores on the Grade 5 STAAR mathematics assessments than their peers in both 2016 and 2018. The mean scores in 2017 were approximately equal with ELL students who attended the early childhood program, having a mean score of 22.09, while ELL students who did not attend

had a mean score of 22.13. The differences in mean scores were not statistically significant in 2016 [F(1, 319) = 1.596, p = .207, partial η^2 = .005], 2017 [F(1, 313) = .002, p = .966, partial η^2 = .000], and 2018 [F(1, 296) = .708, p = .401, partial η^2 = .002]. Non-ELL students had higher scores independent of their placement in the district's early childhood program. The results of the simple effects analysis are summarized in Table 26.

Table 26

Simple Effect of Attending Early Childhood Program on Students' Grade 5 Mathematics Scores for Independent Variable: ELL Status

	F	df	Sig.	ES
2016				
ELL	1.596	1, 319	.207	.005
Not ELL	10.065	1, 1564	.002	.006
2017				
ELL	.002	1, 313	.966	.000
Not ELL	16.534	1, 1561	<.001	.010
2018				
ELL	.708	1, 296	.401	.002
Not ELL	28.472	1, 1555	<.001	.018

Statistically Significant Results for Reading

Latinx Students

I conducted a two-way ANOVA that examined the effect of attending the district's early childhood program and being Latinx on STAAR reading assessment scores in Grades 3, 4, and 5. There were no statistically significant interactions found on any of the STAAR reading assessments in Grade 3 or Grade 4 for Latinx students in any of the cohorts. Summary data tables for ANOVAs with statistically insignificant results are in Appendix C.

There was a statistically significant interaction between attending the early childhood program for Latinx students on Grade 5 reading in 2016 [F (1, 1881) = 5.545, p = .019, partial η^2 = .003]. The ANOVA results are presented in Table 27.

Table 27

Two-way ANOVA Summary Table for Grade 5 2016 Reading: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
Latinx	31.352	1	<.001	.016
ECE	23.099	1	<.001	.012
Latinx*ECE	5.545	1, 1881	.019	.003

The simple effects analysis, presented in Table 28, shows that while Latinx students who did not attend the district's early childhood program have a higher mean score, the differences are not statistically significant [F(1, 517) = 3.215, p = .074, partial η^2 = .006]. Students who are not Latinx have higher scores than Latinx students, independent of placement in the early childhood program. The simple effects analysis results are in Table 27.

Table 28

Simple Effect of Attending Early Childhood Program on Grade 5 2016 Reading Scores for Independent Variable: Latinx

	F	df	Sig.	ES
Latinx	3.215	1, 517	.074	.006
Not Latinx	22.644	1, 1364	<.001	.016

African American Students

I used a two-way ANOVA to examine the effect of attending the district's early childhood program and being African American on STAAR reading assessment raw scores in

Grades 3, 4, and 5. There was statistically significant interaction between factors for some of the testing years in each grade level.

ANOVA results, presented in Table 29, show a statistically significant interaction between factors in Grade 3 reading in 2014 [F 1, 1736) = 8.251, p = .004, partial η^2 = .005]. The 2016 results also showed a statistically significant interaction between factors in Grade 3 reading [F(1, 1805) = 15.862, p < .001, partial η^2 = .009].

Table 29

Two-way ANOVA Summary Table for Grade 3 Reading: African American and Early Childhood Education (ECE)

	F	df	Sig.	ES
2014				
African American	8.592	1	.003	.005
ECE	13.563	1	<.001	.008
African American*ECE	8.251	1, 1736	.004	.005
2016				
African American	20.696	1	<.001	.011
ECE	20.482	1	<.001	.011
African American*ECE	15.862	1, 1805	<.001	.009

A relatively small population of African American students attended the district's early childhood program and tested in 2014 (30 students) and 2016 (40 students). In both testing years, African American students who attended the district's early childhood program had lower mean scores than their African American peers who did not attend. The mean scores were similar to other student groups who attended the district's early childhood program. The simple effects analysis showed that the differences in mean scores between African American students who attended and African American students who did not were not statistically significant in

2014 [F(1, 1820 = .147, p = .702, partial η^2 =.001] or in 2016 [F(1, 241) = .063, p = .802, partial η^2 = .000]. The simple effect analysis is summarized in Table 30.

Table 30

Simple Effect of Attending Early Childhood Program on Students' Grade 3 Reading Scores for Independent Variable: African American

	F	df	Sig.	ES
2014				
African American	.147	1, 182	.702	.001
Not African American	92.972	1, 1554	.001	.056
2016				
African American	.063	1, 241	.802	.000
Not African American	144.374	1, 1564	<.001	.085

Grade 4 reading results, presented in Table 31, showed a statistically significant interaction between factors in 2015 [F(1, 1831) = 6.572, p = .010, partial η^2 = .004], 2017 [F(1, 1853) = 9.681, p = .002, partial η^2 = .005], and 2018 [F(1, 1783) = 9.154, p = .003, partial η^2 = .005]. The effect size estimates are small. The results for the 2016 Grade 4 reading test did not show a statistically significant interaction between factors.

Table 31

Two-way ANOVA Summary Table for Grade 4 Reading: African American and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
African American	18.117	1	<.001	.010
ECE	11.966	1	.001	.006
African American*ECE	6.572	1, 1831	.010	.004
2017				
African American	11.676	1	.001	.006

	F	df	Sig.	ES
ECE	18.552	1	<.001	.010
African American*ECE	9.681	1, 1853	.002	.005
2018				
African American	21.960	1	<.001	.012
ECE	18.372	1	<.001	.010
African American*ECE	9.154	1, 1783	.003	.005

A simple effects analysis, presented in Table 32, was used to determine the effect of attending the district's early childhood program on African American students and non-African American students. The differences in mean scores for African American students who did attend the early childhood program and African American students who did not attend were not statistically significant in any of the years with significant interactions. There was less than one-point difference between the groups' mean scores. Students who are not African American had higher average scores than African American students on Grade 4 reading STAAR assessments in all years, independent of placement in the early childhood program.

Table 32

Simple Effect of Attending Early Childhood Program on Students' Grade 4 Reading Scores for Independent Variable: African American

	F	df	Sig.	ES
2015				
African American	.173	1, 222	.678	.001
Not African American	74.800	1, 1609	<.001	.044
2017				
African American	.360	1, 238	.549	.002
Not African American	113.685	1, 1615	<.001	.066
2018				
African American	.376	1, 238	.540	.002
Not African American	114.563	1, 1550	<.001	.069

The Grade 5 reading STAAR results followed a similar pattern when subjected to a two-way ANOVA to determine if there was an interaction between factors. There was a significant interaction between factors in 2016 [$F(1, 1881) = 5.987$, $p = .014$, partial $\eta^2 = .005$] and 2018 [$F(1, 1847) = 7.157$, $p = .008$, partial $\eta^2 = .004$]. The significant interactions and main effects for African American and early childhood education on Grade 5 reading are summarized in Table 33. There was not a significant interaction between factors for the Grade 5 reading STAAR assessment in 2017.

Table 33

Two-way ANOVA Summary Table for Grade 5 Reading: African American and Early Childhood Education (ECE)

	F	df	Sig.	ES
2016				
African American	10.286	1	.001	.005
ECE	15.973	1	<.001	.008
African American*ECE	5.987	1, 1881	.014	.003
2018				
African American	16.161	1	<.001	.009
ECE	17.502	1	<.001	.009
African American*ECE	7.157	1, 1847	.008	.004

The simple effects analysis, presented in Table 34, showed there were not statistically significant differences in mean scores for African American students who attended the early childhood program and those who did not. The population of African American students attending the early childhood school and taking STAAR Grade 5 assessments was relatively small with 33 students testing in 2016 and 31 in 2018.

Table 34

Simple Effect of Attending Early Childhood Program on Students' Grade 5 Reading Scores for Independent Variable: African American

	F	df	Sig.	ES
2016				
African American	.544	1, 251	.461	.002
Not African American	80.510	1, 1630	<.001	.047
2018				
African American	.520	1, 269	.472	.002
Not African American	100.464	1, 1578	<.001	.060

Students who are Economically Disadvantaged

The two-way ANOVA examining the interaction effect of participating in the district's early childhood program and economically disadvantaged students on STAAR reading scores found statistically significant interactions in Grade 3, 4, and 5.

The interaction between factors was statistically significant for Grade 3 reading in 2017 [$F(1, 1736) = 9.758$, $p = .002$, partial $\eta^2 = .006$] and 2018 [$F(1, 1773) = 13.175$, $p < .001$, partial $\eta^2 = .007$]. The two-way ANOVA data is summarized in Table 35.

Table 35

Two-way ANOVA Summary Table for Grade 3 Reading: Economically-Disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
2017				
Economically Disadvantaged	90.161	1	<.001	.049
ECE	27.032	1	<.001	.015
Economically Disadvantaged *ECE	9.758	1, 1736	.002	.006
2018				
Economically Disadvantaged	88.838	1	<.001	.048
ECE	50.354	1	<.001	.028
Economically Disadvantaged *ECE	13.175	1, 1773	<.001	.007

The simple effects analysis for Grade 3 reading in 2017 showed that attending the early childhood program did not have a statistically significant effect on the STAAR scores of students who are economically-disadvantaged [$F(1, 587) = 2.255$, $p = .137$, partial $\eta^2 = .004$]. The mean score for economically-disadvantaged students who attended the district's early childhood program was one point lower than the mean score for economically-disadvantaged students who did not attend. There was a statistically significant difference between mean scores on the Grade 3 STAAR reading in 2018 [$F(1, 666) = 6.945$, $p = .009$, partial $\eta^2 = .01$]. The effect size estimate was small. Economically-disadvantaged students who did not attend the district's early childhood program had a higher mean score then the economically-disadvantaged students who did attend. The mean scores for students who are not economically disadvantaged were higher, independent of placement in the district's early childhood program. The summary of the simple effects analysis is presented in Table 36.

Table 36

Simple Effect of Attending Early Childhood Program on Students' Grade 3 Reading Scores for Independent Variable: Economically-Disadvantaged

	F	df	Sig.	ES
2017				
Economically-Disadvantaged	2.255	1, 587	.134	.004
Not Economically-Disadvantaged	32.693	1, 1149	<.001	.028
2018				
Economically Disadvantaged	6.945	1, 666	.009	.010
Not Economically-Disadvantaged	51.085	1, 1107	<.001	.044

The interaction between factors was statistically significant on the 2016 and 2018 Grade 4 STAAR reading. The two-way ANOVA results, presented in Table 37, had small effect sizes for 2016 [$F(1, 1831) = 6.428$, $p = .011$, partial $\eta^2 = .004$] and 2018 [$F(1, 1783) = 6.712$, $p = .010$, partial $\eta^2 = .004$].

Table 37

Two-way ANOVA Summary Table for Grade 4 Reading: Economically-Disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
2016				
Economically Disadvantaged	107.821	1	<.001	.056
ECE	21.979	1	<.001	.012
Economically Disadvantaged *ECE	6.428	1, 1831	.011	.004
2018				
Economically Disadvantaged	130.354	1	<.001	.068
ECE	14.566	1	<.001	.008
Economically Disadvantaged *ECE	6.712	1, 1783	.010	.004

The simple effects analysis, summarized in Table 38, showed that attending the early childhood program did not have a statistically significant effect on Grade 4 STAAR reading scores for 2016 [$F(1, 611) = 2.546$, $p = .111$, partial $\eta^2 = .004$] or in 2018 [$F(1, 619) = .820$, $p = .365$, partial $\eta^2 = .001$]. In both years, the mean scores of economically-disadvantaged students who did not attend the early childhood program were higher than the mean scores of economically-disadvantaged students who did attend. Students who were not economically disadvantaged had higher mean scores, independent of their placement at the early childhood program.

Table 38

Simple Effect of Attending Early Childhood Program on Students' Grade 4 Reading Scores for Independent Variable: Economically-Disadvantaged

	F	df	Sig.	ES
2016				
Economically-Disadvantaged	2.546	1, 611	.111	.004
Not Economically-Disadvantaged	24.024	1, 1216	<.001	.019

	F	df	Sig.	ES
2018				
Economically Disadvantaged	.820	1, 619	.365	.001
Not Economically-Disadvantaged	19.226	1, 1164	<.001	.016

I used a two-way ANOVA to investigate the impact of attending the district's early childhood program on Grade 5 STAAR reading scores for students who are economically-disadvantaged. The interaction between factors was statistically significant in 2016 [F(1, 1881) = 11.441, p = .001, partial η^2 = .006]. The effect size estimate was small. The ANOVA for 2016 Grade 5 STAAR reading scores is summarized in Table 39.

Table 39

Two-way ANOVA Summary Table for Grade 5 Reading 2016: Economically-Disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
Economically Disadvantaged	83.386	1	<.001	.042
ECE	11.705	1	.001	.006
Economically Disadvantaged *ECE	11.441	1, 1881	.001	.006

The simple effect analysis, presented in Table 40, showed that attending the early childhood program did not have a statistically significant effect on Grade 5 STAAR reading scores for economically-disadvantaged students [F(1, 636) = .001, p = .976, partial η^2 = .000]. The difference in mean scores between economically-disadvantaged students who attended the program and those who did not was 0.02 points.

Table 40

Simple Effect of Attending Early Childhood Program on Students' Grade 5 2016 Reading Scores for Independent Variable: Economically-Disadvantaged

	F	df	Sig.	ES
Economically Disadvantaged	.001	1, 636	.976	.000
Not Economically Disadvantaged	20.429	1, 1245	<.001	.016

English Language Learners

I used a two-way ANOVA to examine the effect of attending the district's early childhood program and ELL status on STAAR reading assessment raw scores in Grades 3, 4, and 5. The interaction between factors was statistically significant for every grade in every year within the data set.

The Grade 3 reading analysis, presented in Table 41, showed a statistically significant interaction between factors in 2014 [$F(1, 1736) = 10.895$, $p = .001$, partial $\eta^2 = .006$] and in 2015 [$F(1, 1813) = 21.402$, $p < .001$, partial $\eta^2 = .012$]. The Grade 3 reading data also showed a statistically significant interaction between factors in 2016 [$F(1, 1805) = 13.747$, $p < .001$, partial $\eta^2 = .008$], in 2017 [$F(1, 1736) = 7.154$, $p = .008$, partial $\eta^2 = .004$], and in 2018 [$F(1, 1783) = 19.761$, $p < .001$, partial $\eta^2 = .011$]. The effect size estimates were small for all years in the data set.

Table 41

Two-way ANOVA Summary Table for Grade 3 Reading: ELL Status and Early Childhood Education (ECE)

	F	df	Sig.	ES
2014				
ELL	49.732	1	<.001	.028
ECE	10.862	1	.001	.006
ELL*ECE	10.895	1, 1736	.001	.006
2015				
ELL	43.779	1	<.001	.024
ECE	33.927	1	<.001	.018
ELL*ECE	21.402	1, 1813	<.001	.012
2016				
ELL	49.682	1	<.001	.027
ECE	20.492	1	<.001	.011
ELL*ECE	13.747	1, 1805	<.001	.008

	F	df	Sig.	ES
2017				
ELL	19.283	1	<.001	.011
ECE	33.751	1	<.001	.019
ELL*ECE	7.154	1, 1736	.008	.004
2018				
ELL	31.723	1	<.001	.018
ECE	40.795	1	<.001	.022
ELL*ECE	19.761	1, 1783	<.001	.011

The simple effects analysis, shown in Table 42, did not reveal any statistically significant differences in mean scores for ELL students who attended the early childhood program and ELL students who did not attend. The mean scores were often less than 1 point different when ELL students were grouped based on participating in the district's early childhood program. The 2014 Grade 3 reading test scores show that ELL students had the same mean scores, independent of placement at the early childhood program. In 2015, 2017, and 2018, the differences in mean scores were less than 1 point.

Table 42

Simple Effect of Attending Early Childhood Program on Students' Grade 3 Reading Scores for Independent Variable: ELL Status

	F	df	Sig.	ES
2014				
ELL	.000	1, 308	.997	.000
Not ELL	22.481	1, 1428	<.001	.015
2015				
ELL	.508	1, 320	.476	.002
Not ELL	71.356	1, 1493	<.001	.046
2016				
ELL	.242	1, 310	.623	.001
Not ELL	43.360	1, 1495	<.001	.028

	F	df	Sig.	ES
2017				
ELL	3.485	1, 313	.063	.011
Not ELL	45.750	1, 1423	<.001	.031
2018				
ELL	1.386	1, 359	.240	.004
Not ELL	75.879	1, 1414	<.001	.051

A two-way ANOVA was conducted to investigate the interaction between attending the early childhood program and ELL status on the Grade 4 STAAR reading assessments. The two-way ANOVA, summarized in Table 43, showed a statistically significant interaction between factors in 2015 [$F(1, 1831) = 11.651$, $p = .001$, partial $\eta^2 = .006$], in 2016 [$F(1, 1827) = 17.080$, $p < .001$, partial $\eta^2 = .009$], in 2017 [$F(1, 1853) = 10.437$, $p < .001$, partial $\eta^2 = .006$], and in 2018 [$F(1, 1783) = 4.864$, $p = .028$, partial $\eta^2 = .003$]. The effect size estimates were small for all years.

Table 43

Two-way ANOVA Summary Table for Grade 4 Reading: ELL Status and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
ELL	44.003	1	<.001	.023
ECE	7.161	1	.008	.004
ELL*ECE	11.651	1, 1831	.001	.006
2016				
ELL	54.567	1	<.001	.029
ECE	18.210	1	<.001	.010
ELL*ECE	17.080	1, 1827	<.001	.009
2017				
ELL	31.616	1	<.001	.017
ECE	22.091	1	<.001	.012

	F	df	Sig.	ES
ELL*ECE	10.437	1, 1853	.001	.006
2018				
ELL	26.758	1	<.001	.015
ECE	26.854	1	<.001	.015
ELL*ECE	4.864	1, 1783	.028	.003

The simple effect analysis for Grade 4 STAAR reading scores did not find any statistically significant differences in mean scores for ELL students who attended the district's early childhood program and ELL students who did not attend. The differences in mean scores between the groups were less than 1 point in 2015, 2016, and 2017. The difference in mean scores in 2018 was 1.56 points, with ELL students who did not attend the early childhood education program scoring higher. The results of the simple effect analysis are presented in Table 44. The mean scores for students who are not ELL were higher than ELL students, independent of placement in the district's early childhood program in 2015, 2016, 2017, and 2018.

Table 44

Simple Effect of Attending Early Childhood Program on Students' Grade 4 Reading Scores for Independent Variable: ELL Status

	F	df	Sig.	ES
2015				
ELL	.238	1, 326	.626	.001
Not ELL	19.197	1, 1505	<.001	.013
2016				
ELL	.006	1, 324	.940	.000
Not ELL	45.202	1, 1503	<.001	.029
2017				
ELL	.880	1, 312	.349	.003
Not ELL	36.516	1, 1541	<.001	.023

	F	df	Sig.	ES
2018				
ELL	3.102	1, 318	.079	.010
Not ELL	34.340	1, 1465	<.001	.023

There was a statistically significant interaction between the effects of participating in the early childhood program and ELL status on Grade 5 STAAR reading raw scores, summarized in Table 44. In 2016, the interaction had a small effect size estimate [$F(1, 1881) = 11.675$, $p = .001$, partial $\eta^2 = .006$]. The 2017 results showed the interaction was statistically significant [$F(1, 1875) = 9.947$, $p = .002$, partial $\eta^2 = .005$]. The effect size estimate was small. The ANOVA for 2018 Grade 5 reading scores resulted in a statistically significant interaction [$F(1, 1847) = 18.146$, $p < .001$, partial $\eta^2 = .010$]. The estimate of effect size was small.

ELL students who participated in the early childhood program had higher mean scores then ELL students who did not attend in 2016 and 2018. The simple effects analysis, presented in Table 46, showed that the differences in mean scores was not statistically significant for ELL students. Students who have not been identified as ELLs scored higher than ELL students, independent of placement in the early childhood program.

Table 45

Two-way ANOVA Summary Table for Grade 5 Reading: ELL and Early Childhood Education (ECE)

	F	df	Sig.	ES
2016				
ELL	69.977	1	<.001	.036
ECE	6.722	1	.010	.004
ELL*ECE	11.675	1, 1881	.001	.006
2017				
ELL	61.992	1	<.001	.032

	F	df	Sig.	ES
ECE	19.131	1	<.001	.010
ELL*ECE	9.947	1, 1875	.002	.005
2018				
ELL	49.432	1	<.001	.026
ECE	9.159	1	.003	.005
ELL*ECE	18.146	1, 1847	<.001	.010

Table 46

Simple Effect of Attending Early Childhood Program on Students' Grade 5 Reading Scores for Independent Variable: ELL Status

	F	df	Sig.	ES
2016				
ELL	.269	1, 319	.604	.001
Not ELL	20.172	1, 1562	<.001	.013
2017				
ELL	.520	1, 313	.471	.002
Not ELL	34.743	1, 1562	<.001	.022
2018				
ELL	.581	1, 295	.446	.002
Not ELL	31.728	1, 1552	<.001	.020

Summary

In this chapter, I reviewed the results of the two-way factorial ANOVA to determine the effect of participation in the district's early childhood education program on students from different demographic groups. The two-way ANOVA yielded statistically significant interactions between factors for Latinx students, socioeconomic status, and ELL status on STAAR mathematics and reading scores. There were also statistically significant interactions between factors for African American students on reading but not on mathematics. The simple effects analysis showed that the simple effect of attending the district's early childhood program

did not create statistically significant differences in mean scores for students in the demographic groups for most of the years tested. There were statistically significant differences in mean scores for ELL students in Grade 4 mathematics, and for economically disadvantaged students in Grade 3 mathematics, Grade 4 mathematics, and Grade 3 reading. The implications of these findings are discussed in Chapter 5.

CHAPTER 5

SUMMARY AND DISCUSSION OF FINDINGS, IMPLICATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The purpose of this study was to determine the effect of attending a school district's early childhood program on academic achievement, as measured by STAAR mathematics and reading assessment scores in Grades 3, 4, and 5 for students from different demographic groups. The district in this study is a suburban district in north Texas that opened a centralized early childhood school in the fall of 2009 and implemented the Texas Pre-K Guidelines. I analyzed STAAR mathematics and reading scores in Grade 3 from 2014-2018, Grade 4 from 2015-2018, and Grade 5 from 2016-2018, using a quasi-experimental design with non-equivalent control groups. A two-way factorial ANOVA determined the effect of two independent variables—attending or not attending the district's early childhood program, and a demographic factor, such as race/ethnicity, socioeconomic status, or ELL status.

The results of the two-way ANOVA were used to answer the research question: What is the effect of participation in early childhood education on mathematics and reading achievement, as determined by the achievement scores from STAAR exams in Grades 3, 4, and 5? This chapter provides a summary and discussion of the findings, limitations of the study, implications, and recommendations for future research.

Summary and Discussion of Findings

Latinx Students

The two-way factorial ANOVA showed very few interactions between attending the district's early childhood program and being a Latinx student. There were only three interactions that showed statistical significance—Grade 3 mathematics in 2018, Grade 5 mathematics in

2016, and Grade 5 reading in 2016. Latinx students who attended the early childhood program had higher mean scores than their peers in Grade 5 mathematics. Further analysis of the mean differences in this test showed no statistically significant differences between Latinx students that attended and Latinx students that did not. Ansari et al. (2017) estimated that less than 40% of Latinx children attend preschool before entering kindergarten. The sample in this study affirmed that finding, with less than 40% of Latinx students participating in the district's early childhood program. Since being Latinx is not an eligibility criterion for attending the district's early childhood program, it is important to consider how eligibility criteria might be impacting scores for students who attend the early childhood program. Eligibility criteria requires students to be economically-disadvantaged, ELL, or have a disability. Latinx participation in the early childhood program in this district is not closing the opportunity gap as measured by STAAR mathematics and reading assessments.

African American Students

The only statistically significant interactions for African American students and the early childhood program were on reading assessments. The interactions that showed statistical significance were Grade 3 reading in 2014 and 2016, Grade 4 reading in 2015, 2017, and 2018, and Grade 5 reading in 2016 and 2018. None of these interactions showed statistically significant differences in mean scores between African American students who attended the early childhood program and those who did not. In most years, the raw score mean differences were less than a point. The size of the African American population attending the early childhood program was less than 40 students in all years analyzed. It is again important to consider what eligibility criteria African American students that attended the early childhood program met in order to attend. This analysis might be comparing economically-disadvantaged,

ELL, or disabled African American students to their African American peers who do not meet these eligibility criteria. The district's early childhood program does not seem to be a significant factor in closing the opportunity gap between African American students and their peers, which is consistent with findings from other studies (Little, 2017; Phillips et al., 2016; Quinn, 2015).

Economically-Disadvantaged Students

There were statistically significant interactions between attending the district's early childhood program and economically-disadvantaged students in mathematics and reading. The mean mathematics scores for students who attended the early childhood program were higher than economically-disadvantaged students who did not attend for seven of the 12 mathematics tests analyzed. While these differences were only statistically significant on the 2014 Grade 3 mathematics test and the 2015 Grade 4 mathematics test, it is promising that attending the early childhood program seems to improve mathematics outcomes for economically-disadvantaged students. Less than 40% of economically-disadvantaged students in the district are attending the early childhood program. Recruiting more students who meet income guidelines to attend the early childhood program could lead to a narrowing of the opportunity gap in mathematics for economically-disadvantaged students.

The mean reading scores for economically-disadvantaged students who attended the early childhood program were lower than the mean reading scores for students who did not attend. While these differences were only statistically significant on the 2018 Grade 3 reading test, participating in the early childhood program is not closing the opportunity gap for economically-disadvantaged students in reading as measured by the STAAR assessments.

ELL Students

About half of the ELL students in the studied school district attend the district's early

childhood program. There were statistically significant interactions between attending the district's early childhood program and ELL status in both mathematics and reading for every grade and every year in the sample. In mathematics, ELLs who attended the district's early childhood program had higher mean scores than ELLs who did not attend in 10 of the 12 mathematics tests analyzed. The differences in mean scores was only statistically significant on Grade 4 mathematics in 2015. ELLs who attended the early childhood program had a mean score almost three points higher than ELLs who did not attend.

The mean reading scores showed differences of less than two points for ELL students, based on participating in the district's early childhood program. ELL students who did not attend had higher mean reading scores in eight of the 12 tests analyzed but the differences were not statistically significant. This finding is surprising due to the body of research showing PK benefits for ELL students in reading (Ansari et al., 2017, Conger et al., 2019, Halle et al., 2012, Weiland & Yoshikawa, 2013).

Implications and Recommendations for Future Research

This study contributes to the body of research about the impact of early childhood education regarding benefits and the fade out of academic impact over time. The data analyzed in this study showed that the district's early childhood program had little impact on Latinx or African American students' STAAR scores in mathematics or reading. Race/ethnicity is not an eligibility criterion for attending the district's early childhood program. Further study is needed to determine if eligibility criteria, such as ELL status, being economically-disadvantaged, or having a disability, are affecting scores of Latinx Iand African American students who attend the early childhood program. The studied school district's population is about 29% Latinx and 14% African American. It is recommended that this study be replicated in a Texas district

implementing the Texas Pre-K Guidelines with larger Latinx and African American populations to examine the effect of public-school early childhood programs in Texas on narrowing the opportunity gap for minority students.

It was found in this study that the district's early childhood program is benefiting ELL students and economically-disadvantaged students in mathematics. ELL students and economically-disadvantaged students who attend the early childhood program had higher mean scores on STAAR mathematics. This finding echoes similar findings from Phillips, Gormley, and Anderson (2016) on the impact of early childhood programs on mathematics achievement. Currently, only about half of the ELL students in the district attend the early childhood program and less than 40% of economically-disadvantaged students attend. Expanding programs to include more students could help narrow the opportunity gap in mathematics. Further study of the curriculum and instructional practices at the early childhood school could reveal why the program is increasing mathematics achievement.

The results for the early childhood program's impact on STAAR reading assessment scores were disappointing and did not align with research. Further study might be needed to analyze other measures of reading achievement for these demographic groups within the district. Using multiple measures of data could assess if there are differences in reading achievement that were not seen on the STAAR reading assessments. Also, it is recommended that the district analyze the programs and instructional practices the early childhood school uses for phonological awareness since Hagans and Good (2013) found that phonological awareness intervention led to improvement in phonologic awareness and other reading skills.

Further research is also recommended to ascertain the impact of the various programs offered within the district's early childhood program. The district offers both half-day PK and

Head Start programs at the early childhood school. The effect of half-day PK compared to full-day PK should be examined. Studies measuring kindergarten readiness would allow the district to measure growth for students and compare the academic growth rate of students who participate in the early childhood program with their peers. It is also recommended that a future study examine how the elementary school's overall performance impacts students who attended the early childhood program.

Conclusion

The goal of this study was to examine the impact of early childhood education on later academic achievement as measured by the STAAR mathematics and reading assessments in Grades 3, 4, and 5. A two-way factorial ANOVA was used to determine the effect of early childhood education and a demographic factor—Latinx, African American, economically-disadvantaged students, and ELLs. The data analysis revealed that there were statistically significant interactions between the early childhood program and Latinx, economically-disadvantaged students, and ELLs on STAAR mathematics and reading assessments. There were only statistically significant interactions between the early childhood program and African American students on reading assessments. Although students who attended the early childhood program had higher mean scores then their peers on several tests, very few analyses revealed differences that were statistically significant. More study is needed to find what is contributing to the statistically significant differences in STAAR mathematics scores. More study is also needed regarding how to sustain the short-term gains of early childhood programs and closing the opportunity gap. School leaders must continue to examine the role of early childhood education in narrowing the opportunity gap and improving long-term educational outcomes.

APPENDIX A

UNT IRB APPROVAL

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THE OFFICE OF RESEARCH INTEGRITY AND COMPLIANCE
Research and Innovation

December 11, 2018

PI: David Brackett
Study Title: The Impact of Early Childhood Education on Later Academic Achievement

RE: Human Subjects Application # IRB-18-645

Dear Dr. David Brackett:

In accordance with 45 CFR Part 46 Section 46.101, your study titled "The Impact of Early Childhood Education on Later Academic Achievement" has been determined to qualify for an exemption from further review by the UNT Institutional Review Board (IRB).

No changes may be made to your study's procedures or forms without prior written approval from the UNT IRB. Please contact The Office of Research Integrity and Compliance at 940-565-4643 if you wish to make any such changes. Any changes to your procedures or forms after 3 years will require completion of a new IRB application.

We wish you success with your study.

Sincerely,

Shelley Riggs, Ph.D.
Professor
Chair, Institutional Review Board

SR:jm

APPENDIX B

DESCRIPTIVE STATISTICS TABLES

Table B.1

Descriptive Statistics of Grade 3 STAAR Mathematics and Reading Scores by Independent Variable: Latinx

Year	Latinx			Not Latinx		
	N	Mean	SD	N	Mean	SD
Mathematics						
2014	469	31.30	9.248	1262	34.94	8.645
2015	551	28.76	9.911	1267	33.97	9.141
2016	562	30.49	9.712	1247	34.12	9.269
2017	529	21.47	7.433	1209	23.79	6.666
2018	577	20.46	7.457	1200	23.42	6.762
Reading						
2014	469	25.91	6.953	1262	30.29	6.331
2015	550	24.62	8.022	1267	29.58	7.100
2016	562	25.60	8.195	1247	29.61	7.742
2017	529	21.47	7.790	1209	25.13	6.942
2018	577	21.34	7.005	1200	25.15	6.258

Table B.2

Descriptive Statistics of Grade 4 STAAR Mathematics and Reading Scores by Independent Variable: Latinx

Year	Latinx			Not Latinx		
	N	Mean	SD	N	Mean	SD
Mathematics						
2015	515	28.47	9.935	1319	33.09	9.712
2016	567	29.64	10.005	1261	34.80	9.315
2017	567	20.98	7.851	1285	24.56	7.600
2018	541	22.43	7.407	1245	25.00	7.019
Reading						
2015	515	27.42	8.945	1319	32.31	8.109
2016	567	28.01	8.632	1261	33.19	7.173
2017	567	22.37	7.768	1285	26.17	7.165
2018	541	22.76	7.474	1245	26.32	7.021

Table B.3

Descriptive Statistics of Grade 5 STAAR Mathematics and Reading Scores by Independent Variable: Latinx

Year	Latinx			Not Latinx		
	N	Mean	SD	N	Mean	SD
Mathematics						
2016	518	30.56	10.902	1364	35.40	10.448
2017	572	23.10	7.770	1309	26.84	7.038
2018	559	23.11	7.318	1290	26.13	7.127
Reading						
2016	518	29.68	9.540	1364	35.16	8.263
2017	572	24.55	7.917	1309	29.30	7.048
2018	559	25.37	7.636	1290	29.01	7.057

Table B.4

Descriptive Statistics of Grade 3 STAAR Mathematics and Reading Scores by Independent Variable: African American

Year	African American			Not African American		
	N	Mean	SD	N	Mean	SD
Mathematics						
2014	183	28.95	9.979	1548	34.54	8.643
2015	211	27.70	11.096	1607	33.01	9.307
2016	243	27.91	10.460	1566	34.19	9.178
2017	215	18.93	7.471	1523	23.67	6.716
2018	250	19.10	7.402	1527	23.01	6.932
Reading						
2014	183	26.00	7.310	1548	29.47	6.631
2015	211	25.18	8.207	1606	28.46	7.589
2016	243	23.95	8.847	1566	29.04	7.758
2017	215	20.53	7.710	1523	24.51	7.226
2018	250	21.26	6.979	1527	24.34	6.612

Table B.5

Descriptive Statistics of Grade 4 STAAR Mathematics and Reading Scores by Independent Variable: African American

Year	African American			Not African American		
	N	Mean	SD	N	Mean	SD
Mathematics						
2015	224	25.76	10.602	1610	32.64	9.610
2016	231	27.66	10.607	1597	34.00	9.448
2017	239	19.26	8.428	1613	24.09	7.569
2018	235	19.96	7.609	1551	24.87	6/953
Reading						
2015	224	26.37	9.565	1610	31.58	8.303
2016	231	28.93	8.373	1597	31.97	7.897
2017	239	21.54	7.693	1613	25.52	7.404
2018	235	21.30	7.634	1551	25.84	7.114

Table B.6

Descriptive Statistics of Grade 5 STAAR Mathematics and Reading Scores by Independent Variable: African American

Year	African American			Not African American		
	N	Mean	SD	N	Mean	SD
Mathematics						
2016	252	28.16	11.067	1630	34.98	10.457
2017	246	21.92	7.992	1635	26.28	7.217
2018	271	21.64	7.920	1578	25.83	7.029
Reading						
2016	252	29.87	9.802	1630	34.23	8.694
2017	246	25.19	8.487	1635	28.26	7.423
2018	271	24.29	7.913	1578	28.53	7.158

Table B.7

Descriptive Statistics of Grade 3 STAAR Mathematics and Reading Scores by Independent Variable: Students who are Economically-Disadvantaged

Year	Economically-Disadvantaged			Not Economically Disadvantaged		
	N	Mean	SD	N	Mean	SD
Mathematics						
2014	573	29.69	9.635	1185	36.06	7.788
2015	632	27.29	10.002	1186	35.11	8.313
2016	633	28.31	9.913	1176	36.05	8.244
2017	587	19.81	7.684	1151	24.75	5.952
2018	668	19.18	7.413	1109	24.43	6.163
Reading						
2014	572	25.18	6.964	1185	31.04	5.790
2015	632	23.57	7.799	1185	30.48	6.533
2016	633	23.57	8.345	1176	30.94	6.665
2017	587	19.90	7.868	1151	26.12	6.179
2018	668	20.50	6.727	1109	25.96	5.876

Table B.8

Descriptive Statistics of Grade 4 STAAR Mathematics and Reading Scores by Independent Variable: Students who are Economically-Disadvantaged

Year	Economically-Disadvantaged			Not Economically Disadvantaged		
	N	Mean	SD	N	Mean	SD
Mathematics						
2015	602	26.69	10.168	1232	34.29	8.896
2016	613	27.85	9.990	1215	35.90	8.562
2017	602	18.83	7.972	1250	25.70	6.741
2018	621	20.51	7.579	1165	26.20	6.197
Reading						
2015	602	26.08	9.018	1232	33.32	7.355
2016	613	26.92	8.527	1215	33.94	6.602
2017	602	20.55	7.482	1250	27.15	6.601
2018	621	20.87	7.723	1165	27.58	5.940

Table B.9

Descriptive Statistics of Grade 5 STAAR Mathematics and Reading Scores by Independent Variable: Students who are Economically-Disadvantaged

Year	Economically-Disadvantaged			Not Economically Disadvantaged		
	N	Mean	SD	N	Mean	SD
Mathematics						
2016	636	28.59	11.047	1246	36.86	9.517
2017	624	21.21	7.588	1257	27.95	6.309
2018	630	21.26	7.347	1219	27.26	6.407
Reading						
2016	636	28.39	9.553	1246	36.33	7.331
2017	624	23.29	8.026	1257	30.13	6.310
2018	630	23.38	7.589	1219	30.25	6.150

Table B.10

Descriptive Statistics of Grade 3 STAAR Mathematics and Reading Scores by Independent Variable: English Language Learners

Year	ELL			Not ELL		
	N	Mean	SD	N	Mean	SD
Mathematics						
2014	309	31.20	9.213	1422	34.55	8.791
2015	322	28.02	10.075	1496	33.33	9.331
2016	312	28.98	9.994	1497	34.25	9.263
2017	314	21.48	7.460	1424	23.44	6.832
2018	361	20.36	7.292	1416	22.99	6.988
Reading						
2014	309	24.84	6.776	1422	30.03	6.429
2015	322	23.25	7.863	1495	29.12	7.299
2016	312	23.39	8.260	1497	29.39	7.673
2017	314	20.42	7.818	1424	24.81	7.069
2018	361	20.44	6.807	1416	24.80	6.443

Table B.11

Descriptive Statistics of Grade 4 STAAR Mathematics and Reading Scores by Independent Variable: English Language Learner

Year	ELL			Not ELL		
	N	Mean	SD	N	Mean	SD
Mathematics						
2015	328	27.97	9.856	1506	32.63	9.826
2016	326	29.21	10.200	1502	34.07	9.531
2017	312	19.87	8.063	1540	24.19	7.607
2018	320	22.30	7.615	1466	24.64	7.081
Reading						
2015	328	26.00	8.812	1506	32.02	8.213
2016	326	26.56	8.965	1502	32.68	7.362
2017	312	20.90	7.562	1540	25.84	7.283
2018	320	21.64	7.868	1466	26.03	6.984

Table B.12

Descriptive Statistics of Grade 5 STAAR Mathematics and Reading Scores by Independent Variable: English Language Learner

Year	ELL			Not ELL		
	N	Mean	SD	N	Mean	SD
Mathematics						
2016	321	29.69	10.905	1561	34.96	10.548
2017	315	22.11	8.052	1566	26.43	7.129
2018	297	21.91	7.506	1552	25.85	7.108
Reading						
2016	321	27.69	9.232	1561	34.87	8.412
2017	315	22.81	8.091	1566	28.88	7.127
2018	297	23.26	7.591	1552	28.80	7.053

APPENDIX C

SUMMARIES OF TWO-WAY FACTORIAL ANOVA WITH NO STATISTICAL SIGNIFICANCE

Table C.1

Two-way ANOVA Summary Table for Grade 3 Mathematics: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
2014				
Latinx	15.793	1	<.001	.009
ECE	3.023	1	.082	.002
Latinx*ECE	3.404	1, 1751	.065	.002
2015				
Latinx	32.799	1	<.001	.018
ECE	31.254	1	<.001	.017
Latinx*ECE	2.127	1, 1814	.145	.001
2016				
Latinx	11.752	1	.001	.006
ECE	31.056	1	<.001	.017
Latinx*ECE	3.190	1, 1807	.074	.002
2017				
Latinx	6.192	1	.013	.004
ECE	25.310	1	<.001	.014
Latinx*ECE	2.515	1, 1736	.113	.001

Table C.2

Two-way ANOVA Summary Table for Grade 4 Mathematics: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
Latinx	21.631	1	<.001	.012
ECE	2.201	1	.138	.001
Latinx*ECE	3.563	1, 1833	.059	.002
2016				
Latinx	32.898	1	<.001	.018
ECE	16.504	1	<.001	.009
Latinx*ECE	1.943	1, 1827	.163	.001

	F	df	Sig.	ES
2017				
Latinx	16.559	1	<.001	.009
ECE	24.269	1	<.001	.013
Latinx*ECE	1.341	1, 1736	.247	.001
2018				
Latinx	12.828	1	<.001	.007
ECE	18.658	1	<.001	.010
Latinx*ECE	.486	1, 1783	.486	.000

Table C.3

Two-way ANOVA Summary Table for Grade 5 Mathematics: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
2017				
Latinx	37.796	1	<.001	.020
ECE	13.679	1	<.001	.007
Latinx*ECE	.050	1, 1874	.823	.000
2018				
Latinx	13.641	1	<.001	.007
ECE	19.008	1	<.001	.010
Latinx*ECE	.767	1, 1851	.381	.000

Table C.4

Two-way ANOVA Summary Table for Grade 3 Mathematics: African American and Early Childhood Education (ECE)

	F	df	Sig.	ES
2014				
African American	30.280	1	<.001	.017
ECE	3.042	1	0.81	.002
African American*ECE	1.464	1, 1751	.226	.001

	F	df	Sig.	ES
2015				
African American	25.613	1	<.001	.014
ECE	23.645	1	<.001	.013
African American*ECE	2.045	1, 1814	.153	.001
2016				
African American	40.400	1	<.001	.022
ECE	21.408	1	<.001	.012
African American*ECE	2.498	1, 1807	.114	.001
2017				
African American	50.881	1	<.001	.028
ECE	20.452	1	<.001	.012
African American *ECE	.008	1, 1736	.927	.000
2018				
African American	43.746	1	<.001	.024
ECE	30.769	1	<.001	.017
African American *ECE	.020	1, 1774	.888	.000

Table C.5

Two-way ANOVA Summary Table for Grade 4 Mathematics: African American and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
African American	30.905	1	<.001	.017
ECE	2.142	1	.143	.001
African American*ECE	3.714	1, 1833	.054	.002
2016				
African American	33.059	1	<.001	.018
ECE	14.116	1	<.001	.008
African American*ECE	2.418	1, 1827	.120	.001
2017				
African American	27.464	1	<.001	.015
ECE	16.795	1	<.001	.009

	F	df	Sig.	ES
African American*ECE	2.877	1, 1851	.090	.002
2018				
African American	37.816	1	<.001	.021
ECE	9.888	1	.002	.006
African American*ECE	2.840	1, 1783	.092	.002

Table C.6

Two-way ANOVA Summary Table for Grade 5 Mathematics: African American and Early Childhood Education (ECE)

	F	df	Sig.	ES
2016				
African American	26.763	1	<.001	.014
ECE	3.955	1	.047	.002
African American*ECE	3.429	1, 1883	.064	.002
2017				
African American	21.138	1	<.001	.011
ECE	11.707	1	.001	.006
African American*ECE	3.047	1, 1874	.081	.002
2018				
African American	23.394	1	<.001	.012
ECE	14.674	1	<.001	.008
African American*ECE	2.275	1, 1851	.132	.001

Table C.7

Two-way ANOVA Summary Table for Grade 3 Mathematics: Economically-disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
Economically Disadvantaged	104.820	1	<.001	.055
ECE	7.549	1	.006	.004
Economically Disadvantaged *ECE	1.967	1, 1814	.161	.001

	F	df	Sig.	ES
2016				
Economically Disadvantaged	115.372	1	<.001	.060
ECE	2.607	1	.107	.001
Economically Disadvantaged *ECE	.096	1, 1807	.757	.000

Table C.8

Two-way ANOVA Summary Table for Grade 4 Mathematics 2017: Economically-disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
Economically Disadvantaged	134.192	1	<.001	.068
ECE	1.573	1	.210	.001
Economically Disadvantaged *ECE	.621	1, 1851	.431	.000

Table C.9

Two-way ANOVA Summary Table for Grade 5 Mathematics: Economically-disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
2017				
Economically Disadvantaged	151.620	1	<.001	.075
ECE	.619	1	.432	.000
Economically Disadvantaged *ECE	1.896	1, 1874	.169	.001
2018				
Economically Disadvantaged	111.128	1	<.001	.057
ECE	.708	1	.400	.000
Economically Disadvantaged *ECE	.097	1, 1851	.756	.000

Table C.10

Two-way ANOVA Summary Table for Grade 3 Reading: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
2014				
Latinx	46.384	1	<.001	.026
ECE	24.944	1	<.001	.014
Latinx *ECE	1.450	1, 1736	.229	.001
2015				
Latinx	53.737	1	<.001	.029
ECE	65.222	1	<.001	.035
Latinx *ECE	.109	1, 1813	.741	.000

Table C.11

Two-way ANOVA Summary Table for Grade 3 Mathematics: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
2016				
Latinx	27/461	1	<.001	.015
ECE	47/625	1	<.001	.026
Latinx *ECE	.227	1, 1805	.634	.000
2017				
Latinx	26.556	1	<.001	.015
ECE	52.770	1	<.001	.030
Latinx *ECE	.000	1, 1736	.988	.000
2018				
Latinx	35.912	1	<.001	.020
ECE	71.756	1	<.001	.039
Latinx *ECE	3.271	1, 1773	.071	.002

Table C.12

Two-way ANOVA Summary Table for Grade 4 Reading: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
Latinx	29.882	1	<.001	.016
ECE	19.732	1	<.001	.011
Latinx *ECE	2.777	1, 1831	.096	.002
2016				
Latinx	55.495	1	<.001	.029
ECE	38.305	1	<.001	.021
Latinx *ECE	.529	1, 1827	.467	.000
2017				
Latinx	30.194	1	<.001	.016
ECE	35.368	1	<.001	.019
Latinx *ECE	.159	1, 1853	.690	.000
2018				
Latinx	33.492	1	<.001	.018
ECE	42.976	1	<.001	.024
Latinx *ECE	.467	1, 1783	.494	.000

Table C.13

Two-way ANOVA Summary Table for Grade 5 Reading: Latinx and Early Childhood Education (ECE)

	F	df	Sig.	ES
2017				
Latinx	55.701	1	<.001	.029
ECE	38.815	1	<.001	.020
Latinx *ECE	.170	1, 1875	.680	.000
2018				
Latinx	23.219	1	<.001	.012
ECE	29.486	1	<.001	.016
Latinx *ECE	.094	1, 1847	.759	.000

Table C.14

Two-way ANOVA Summary Table for Grade 3 Reading: African American and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
African American	13.921	1	<.001	.008
ECE	49.426	1	<.001	.027
African American *ECE	1.998	1, 1814	.158	.001
2017				
African American	22.420	1	<.001	.013
ECE	31.324	1	<.001	.018
African American *ECE	2.571	1, 1736	.109	.001
2018				
African American	23.114	1	<.001	.013
ECE	50.634	1	<.001	.028
African American *ECE	1.424	1, 1774	.233	.001

Table C.15

Two-way ANOVA Summary Table for Grade 4 2016 Reading: African American and Early Childhood Education (ECE)

	F	df	Sig.	ES
African American	7.872	1	.005	.004
ECE	28.854	1	<.001	.016
African American*ECE	3.222	1, 1827	.073	.002

Table C.16

Two-way ANOVA Summary Table for Grade 5 2017 Reading: African American and Early Childhood Education (ECE)

	F	df	Sig.	ES
African American	8.114	1	.004	.004
ECE	28.175	1	<.001	.015
African American*ECE	3.485	1, 1875	.062	.002

Table C.17

Two-way ANOVA Summary Table for Grade 3 Reading: Economically-disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
2014				
Economically Disadvantaged	90.586	1	<.001	.050
ECE	11.041	1	.001	.006
Economically Disadvantaged *ECE	3.364	1, 1736	.067	.002
2015				
Economically Disadvantaged	132.042	1	<.001	.068
ECE	25.977	1	<.001	.014
Economically Disadvantaged *ECE	.353	1, 1813	.552	.000
2016				
Economically Disadvantaged	159.394	1	<.001	.081
ECE	7.944	1	.005	.004
Economically Disadvantaged *ECE	.185	1, 1805	.667	.000

Table C.18

Two-way ANOVA Summary Table for Grade 4 Reading: Economically-disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
2015				
Economically Disadvantaged	91.743	1	<.001	.043
ECE	5.749	1	.017	.003
Economically Disadvantaged *ECE	3.329	1, 1831	.068	.002
2017				
Economically Disadvantaged	128.704	1	<.001	.065
ECE	9.081	1	.003	.005
Economically Disadvantaged *ECE	.235	1, 1853	.628	.000

Table C.19

Two-way ANOVA Summary Table for Grade 5 Reading: Economically-disadvantaged and Early Childhood Education (ECE)

	F	df	Sig.	ES
2017				
Economically Disadvantaged	151.993	1	<.001	.075
ECE	14.708	1	<.001	.008
Economically Disadvantaged *ECE	.038	1, 1875	.845	.000
2018				
Economically Disadvantaged	143.063	1	<.001	.072
ECE	3.240	1	.072	.002
Economically Disadvantaged *ECE	.168	1, 1847	.682	.000

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