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KINDERGARTEN READINESS AND GRADE 1 MATHEMATICS ACHIEVEMENT

By

Faneshia McPherson Jones
B.A., University of Louisville, 1998
M.A.T., Eastern Kentucky University, 2005
M.A.Ed., Eastern Kentucky University, 2011

A Dissertation
Submitted to the Faculty of the
College of Education and Human Development of the
University of Louisville
in Partial Fulfillment of the Requirements
for the Degree of

Doctor of Education in Educational Leadership and Organizational Development

Department of Educational Leadership and Organizational Development
University of Louisville
Louisville, Kentucky

December 2020

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A Dissertation Approved on

October 19, 2020

By the following Dissertation Committee:

Dr. Jason Immekus, Chair

Dr. William Kyle Ingle

Dr. Tiffany Marshall

Dr. Deborah Powers

DEDICATION

This dissertation is dedicated to
the legacy of determination, courage, and inspiration of the students and staff
of the Lancaster Colored School and Mason High School in Garrard County, Kentucky.

~WE WILL REMEMBER~

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First and foremost, I thank God for blessing me with this opportunity. To my dissertation chair and committee, thank you for being generous with your time, guidance, and support. The completion of my dissertation would not have been possible without your belief in my potential. To my parents, thank you for your prayers and the love that you have consistently shown. I am grateful that you have always supported my academic and professional aspirations. To my husband, your understanding and patience throughout this process was a blessing. Thank you for taking this journey with me and for providing encouragement when I needed it most.

ABSTRACT

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Faneshia McPherson Jones

October 19, 2020

From 2013-2019, all Kentucky school districts have administered a common screener to each student entering kindergarten. In this study, kindergarten readiness—determined by academic skills/cognitive development, language development, and physical development—was a significant predictor of grade 1 end-of-year mathematics achievement. The model predictions show that kindergarten students who met the readiness benchmark had higher grade 1 end-of-year mathematics scores compared to students who entered kindergarten below the readiness benchmark. The model predictions improved substantially with the inclusion of prior level of achievement as indicated by grade 1 beginning of the year mathematics achievement. However, students with stronger readiness skills demonstrated significantly higher grade 1 mathematics scores compared to students with lower readiness skills, irrespective of whether prior level of achievement was controlled. These findings suggest that the achievement of students before and during the kindergarten year are significant predictors of subsequent grade 1 mathematics achievement even after controlling for students' demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status. Implications for policy, practice, and research are discussed.

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CHAPTER 1: INTRODUCTION

From 2011-2013, the U.S. Departments of Education and Health and Human Services granted over \$1 billion in Race to the Top-Early Learning Challenge (RTT-ELC) funding to 20 states, including over \$44 million to the state of Kentucky (U.S. Department of Education, 2017; U.S. Department of Health and Human Services, 2017). Specifically, allocated funds were intended to support the implementation of efforts to improve the quality of early childhood education programs, to increase program access for traditionally underserved populations, and to address readiness gaps at kindergarten entry (Race to the Top-Early Learning Challenge, 2013). Research examining access to high-quality early care and learning programs clearly document that traditionally underserved populations include children from economically disadvantaged homes and communities (Bassok & Galdo, 2016; Hatfield, Lower, Cassidy, & Faldowski, 2015). Previous research also documents disparities in children's cognitive and non-cognitive skills at kindergarten entry that are correlated with social and demographic factors, in particular the economic status of the child's household and neighborhood as well as race/ethnicity and native language (Garcia, 2015; Garcia & Weiss, 2017; Kenly, Klein, & Nicholson, 2017). The RTT-ELC grant application required states to include a plan to administer a statewide kindergarten entry assessment to all children entering a public-school kindergarten to inform efforts to close the readiness gap at kindergarten entry and to sustain early learning outcomes through early elementary grades K-2 (U.S. Department of Education, 2011).

Because of the RTT-ELC grant program, more systematic attention has been placed on the use of kindergarten entry assessments and efforts to close early achievement and opportunity gaps (Ackerman, 2018; Krasnoff, 2015). Despite increased attention and expanded investments in early childhood education, there is little empirical evidence of improved early learning outcomes that are sustained and extended into early elementary grades (Bassok & Latham, 2017; McCoy et al., 2017). Furthermore, emerging evidence suggests an association between kindergarten readiness and neighborhood advantage and disadvantage (Roy, McCoy, & Raver, 2014; Wolf, Magnuson, & Kimbro, 2017). However, Morrissey and Vinopal (2018b) in the following statement call attention to research gaps: “Few studies have examined neighborhood disadvantage and young children’s school readiness and whether associations between neighborhood disadvantage and children’s outcomes persist as children enter and age through the K-12 education system” (p.194). The aim of this study was to extend this area of investigation by examining the relationship between kindergarten readiness and grade 1 end-of-year mathematics outcomes, controlling for students’ demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status.

According to information compiled by the Council of Chief State School Officers (CCSSO, 2019), the measurement and reporting of learning outcomes in early elementary grades vary between schools, districts, and states. In an analysis of state adoption and implementation of K-2 assessments, Croft (2016) indicates that data reported to the public was not usually disaggregated by student characteristics, which limits public information about differences in achievement between student groups across the K-2 continuum. In contrast, under the Every Student Succeeds Act (ESSA), state education

agencies are required to report aggregated and disaggregated data on student academic achievement for grades 3-12 publicly (Every Student Succeeds Act, 2015). Additionally, ESSA (2015) and Kentucky Revised Statute (KRS) 160.346 require that the Kentucky Department of Education use indicators from the statewide accountability system to identify schools and student groups with the lowest performance. This requirement provides data that allows for comparisons of the academic achievement of schools and student groups in grades 3-12; however, there are no publicly available data sets to identify the development of early achievement gaps in grades K-2. As discussed in the subsequent section, trends in kindergarten readiness levels in the state of Kentucky indicate that gaps in knowledge and skills between students with differing demographic characteristics begin prior to kindergarten entry.

Under 704 Kentucky Administrative Regulation (KAR) 5:070, all Kentucky school districts are required to administer a common screener, the BRIGANCE Early Childhood Kindergarten Screen III (French, 2013), to each student entering kindergarten. According to the Kentucky Department of Education (2019b), in the 2018-2019 school year BRIGANCE was administered to 47,906 kindergarten students in all 173 school districts and 51.1% of students were identified as kindergarten ready. Consequently, however, 48.9% of students entered school less prepared than their peers to engage in and benefit from the Kentucky Academic Standards for kindergarten students. Notably, 75% of these students live in households that met the income eligibility guidelines under the National School Lunch Program (NSLP) to qualify for free meals or reduced-price meals (FRL) (Kentucky Department of Education, 2019b). Free meals are provided for students from households with income levels at or below 130 percent of the Federal poverty level.

Reduced-price meals are provided for students from households with income levels between 130 and 185 percent of the Federal poverty level (U.S. Department of Agriculture, 2017). Additionally, the percent of African American and Latinx students in Kentucky who demonstrated readiness for kindergarten was 51.9% and 34.8%, respectively. Among English language learners (ELL), 35.8% demonstrated readiness for kindergarten (Kentucky Department of Education, 2019b).

Jefferson County Public Schools (JCPS), the largest school district in Kentucky and the 29th largest in the United States, had a total enrollment of 98,361 students in the 2018-2019 school year. This urban school district has a total of 169 schools, including 66 magnet schools and programs, which serve students from pre-K through grade 12 (JCPS District Profile, 2019). Among the 169 schools, 79.3% meet the federal guidelines under the NSLP for the Community Eligibility Provision which provides breakfast and lunch at no cost to students enrolled in high-poverty schools and districts (Food Research & Action Center, 2018; U.S. Department of Agriculture, 2019). In 2018-2019, student enrollment data for the district reflected a racial composition of 42% White, 37% African American, 12% Latinx, and 10% Other with 51.2% of students identified as male and 48.8% of students identified as female (JCPS Data Books, 2018a). There are also 125 languages spoken by JCPS students and for 8% of students English is a second language (JCPS District Profile, 2019). From 2013-2017, the average median household income of JCPS students in a zip code ranged from \$17,447-\$110,416 with high concentrations of poverty in communities of color (JCPS Accountability, Research, & Systems Improvement, 2019). In the 2018-2019 school year, at least 5,000 of the approximate 7,500 students enrolled in kindergarten lived in households that met the income eligibility

guidelines for FRL. While the overall FRL participation rate in the district's elementary schools is 64.8%, African American (81.8%) and Other (68%) students have higher participation rates compared to White (48.8%) students (JCPS Data Books, 2018b).

Figure 1 reports data from 2013 to 2018 that indicates the percent of students in JCPS who were identified as kindergarten ready. Administered by JCPS since 2013, BRIGANCE results have consistently shown disparities in kindergarten readiness levels across student groups, with outcomes at the highest and lowest levels reflecting differences associated with the economic status of the family as well as the student's racial and ethnic background and English language proficiency. The data shows that from 2013-2018 the percent of all students identified as kindergarten ready ranged from 47.9% to 54.9%. Among students eligible for FRL the range was 39% to 49.3% and for English language learners the range was 21.5% to 29.1%. In 2013, the percent of White students identified as kindergarten ready was 60.3% compared to 46.9% of African American students and 30.1% of Latinx students. In 2015, there was a decrease across all demographic groups in the percent of students identified as kindergarten ready followed by increases for all in 2016 and 2017 and decreases for all in 2018. In 2018, the percent of White students identified as kindergarten ready was 58.1% compared to 51.2% of African American students and 27.3% of Latinx students. Although the trend has slightly varied from year to year, it is clear that differences in kindergarten readiness exist across demographic groups.

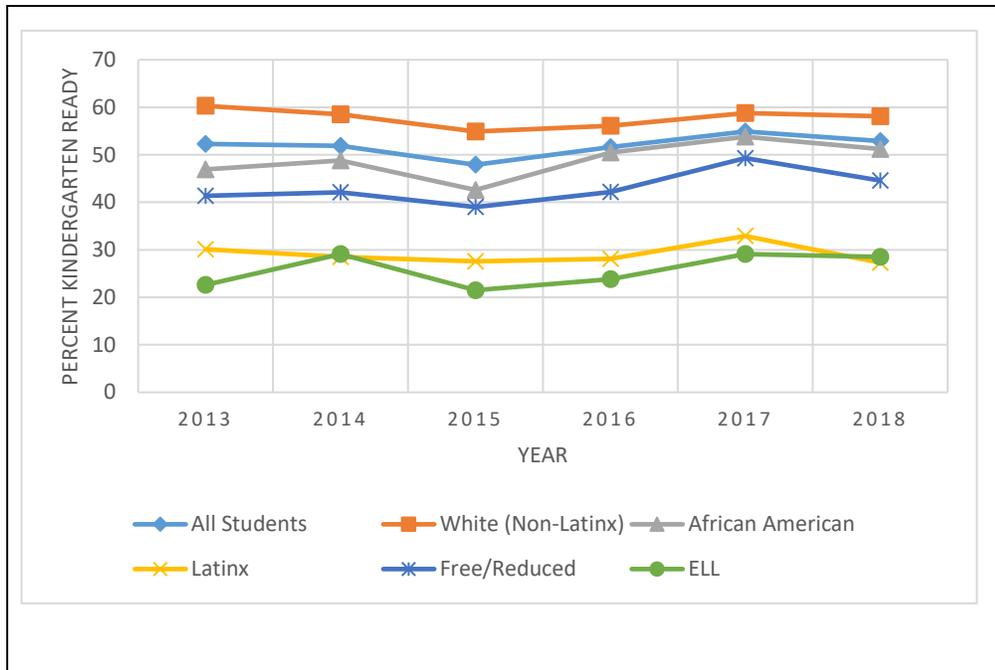


Figure 1. Kindergarten readiness by demographic group from 2013-2018 for JCPs. Adapted from Kentucky Department of Education (2019b) Open House Data.

These trends in kindergarten readiness indicate that students from different backgrounds enter kindergarten with varying levels of foundational knowledge and skills. Given these disparities at kindergarten entry, it is important to consider whether these gaps in performance associated with demographic characteristics persist or diminish in early elementary grades. The current study examined whether a predictive relationship exists between kindergarten readiness and early elementary achievement. Given the preliminary descriptive statistics that show differences in kindergarten readiness between student groups, this study included student demographic characteristics of race, gender, and language as control variables. This study also included students' prior setting for early care and learning and neighborhood socioeconomic status as control variables. As discussed in the forthcoming section, social advantage or disadvantage influences access to educational resources and opportunities—and subsequently, educational outcomes.

Theoretical Framework

For decades, educational researchers have documented race-based and class-based achievement gaps and prioritized efforts to address educational inequities (Valant & Newark, 2016). The National Center for Educational Statistics (de Brey et al., 2019) defines the term achievement gap as the gap that “occurs when an outcome—for example, average test score or level of educational attainment—is higher for one group than for another group, and the difference between the two groups’ outcomes is statistically significant” (p. 204). Previous research clearly documents persistent achievement gaps between students from different racial and ethnic groups and between students from low- and high-income households and communities (Coleman et al., 1966; de Brey et al., 2019; Harris & Herrington, 2006; Jencks & Phillips, 1998; Lee, 2002). There is, however, a parallel body of research that gives emphasis to the link between disparities in academic performance and educational attainment and disparities in educational and social opportunities (Carter & Welner, 2013). The theoretical framework underpinning that body of research is the opportunity gap frame. According to Pflieger, Wilson, Welner, and Bibilos (2018), the opportunity gap frame takes account of an interdisciplinary research base (Carter & Welner, 2013; Gamoran, 2001; Ladson-Billings, 2006; Milner, 2013; Rothstein, 2004, 2006) to establish a theoretical basis for the study of achievement gaps within a framework that does not ignore the disparities in opportunities that occur in the broader context of social inequality.

Welner and Carter (2013) contend that achievement gaps are the result of opportunity gaps and suggest that framing, or identification of the problem, influences

how researchers, educators, and policy makers address this issue. Consistent with this viewpoint, they state:

The ‘opportunity gap’ frame shifts our attention from outcomes to inputs—to the deficiencies in the foundational components of societies, schools, and communities that produce significant differences in educational—and ultimately socioeconomic—outcomes. Thinking in terms of ‘achievement gaps’ emphasizes the symptoms; thinking about unequal opportunity highlights the causes. (Welner & Carter, 2013, p. 3)

In other words, disparities in educational outcomes between students from different backgrounds emphasize the need for more equitable educational and social opportunities—equity in access, equity in participation, and equity of outcomes (Brookover & Lezotte, 1981; Jenlink, 2009). As applied to this study, the opportunity gap framework indicates that advantage and disadvantage that vary by child, family, and community characteristics may influence access to opportunities and resources that support child development and readiness at school entry. Taken together, the trend of varying kindergarten readiness levels between demographic groups and the opportunity gap framework provided the basis for this study.

Indeed, achievement gaps by race and class in early childhood are well-documented in studies that examine large-scale datasets and nationally representative samples of children from birth to kindergarten entry (Wang, 2010). Prior studies indicate that race-based achievement gaps that emerge in early childhood increase over time, and the magnitude of the mathematics achievement gap is greater than the reading achievement gap (Wang, 2008). Additionally, a seminal study by Lee and Burkam

(2002) has clearly established that early achievement gaps by race and class also reflect social and educational disadvantages including poor neighborhood and school conditions. These studies suggest the importance of examining kindergarten readiness and early elementary mathematics achievement controlling for known factors associated with social and educational disadvantage—student demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status. As discussed in the following section, prior research suggests that mathematics achievement and growth in early childhood including early elementary grades K and 1 establish the trajectory for mathematics achievement from elementary school into high school.

Statement of Purpose and Research Question

In this study, a non-experimental correlational design was used to understand the relationship between kindergarten readiness and subsequent mathematics achievement. More specifically, the purpose of this study was to examine whether kindergarten readiness predicts grade 1 end-of-year mathematics achievement controlling for students' demographic characteristics and contextual factors—race/ethnicity, gender, language, prior setting the year before kindergarten entry, and neighborhood socioeconomic status. Multiple regression analysis was used to determine how well kindergarten readiness taken together with these characteristics and factors predict subsequent grade 1 math achievement.

Under ESSA (2015), all state assessment and accountability systems must hold schools and districts accountable for student performance in English language arts and mathematics. Kentucky's school accountability system for elementary and middle schools includes equal weight for proficiency in reading and mathematics and a growth

indicator that compares current performance to prior year performance in both content areas. Proficiency and growth indicators for reading and mathematics comprise 70% of a school's overall accountability score (703 KAR 5:270; Kentucky Department of Education, 2019a). Under this accountability system, the percent of students scoring proficient in reading in 2018-2019 school year was 54.6% in elementary school and 59.6% in middle school. For the same school year, 48.6% of elementary students and 46.4% of middle school students scored proficient in mathematics. These differences were also evident in the 2017-2018 school year (Kentucky Department of Education, 2019c). Given the equal emphasis in the accountability system on reading and mathematics and the differences in student performance in these content areas, this study will provide educational leaders with information specific to early achievement and opportunity gaps that may inform later mathematics achievement outcomes.

Previous studies have linked achievement status and growth in preschool and early elementary grades to later elementary school achievement (Byrnes & Wasik, 2009; Classens, Duncan, & Engel, 2009; Jordan, Kaplan, Ramineni, & Locuniak, 2009). In a meta-analysis of six large-scale longitudinal studies, Duncan et al. (2007) found that reading, mathematics, and attention skills at kindergarten entry were all predictors of subsequent achievement outcomes. However, early mathematics skills, with an average standardized regression coefficient of .33, was a better predictor of later reading achievement and later mathematics achievement when compared to the predictive power of early reading skills (.13) and attention skills (.07). This meta-analysis also indicated that the association between early academic skills and later achievement changed over time (i.e., years between the measures at kindergarten entry and measures of elementary

outcomes). The change for both reading (-.012) and mathematics (-.005) were negative, but the association remained more consistent for mathematics than for reading. In general, these results show that students' early academic skills are predictive of students' later achievement in elementary school, particularly achievement in early elementary school.

Additionally, previous studies have demonstrated a correlation between early measures of mathematics achievement and later mathematics achievement in middle school and high school (Bailey, Siegler, & Geary, 2014; Geary, Hoard, Nugent, & Bailey, 2013; Jordan et al., 2009; Siegler et al., 2012). In a study conducted by Watts, Duncan, Siegler, and Davis-Kean (2014), the results demonstrated a statistically significant correlation ($r = .504, p < .001$) between mathematics skills prior to school entry and mathematics achievement in high school. Furthermore, the results demonstrated a stronger correlation ($r = .641, p < .001$) between gains in mathematics skills from preschool to the end of first grade and mathematics skills in high school. The findings of this study demonstrate the long-term benefit of learning opportunities that promote mathematics achievement and growth in early elementary grades K and 1.

Together, these aforementioned studies suggest that academic skills, particularly mathematics skills that develop prior to kindergarten entry through the end of first grade, influence student mathematics outcomes into high school. Consequently, it is important to understand whether disparities in kindergarten readiness evident between demographic groups increase, decrease, or remain the same in early elementary grades. It is also important to understand whether opportunity gaps, like access to high-quality early childhood education programs and neighborhood socioeconomic status, may predict early

achievement gaps between demographic groups. Thus, the current study investigated the following research question:

RQ1: Does kindergarten readiness predict grade 1 end-of-year mathematics achievement, controlling for students' demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status?

The following were my hypotheses regarding the research question that guides this study:

H1₀: There is no relationship between kindergarten readiness and grade 1 end-of-year mathematics achievement.

H1₁: There is a positive relationship between kindergarten readiness and grade 1 end-of-year mathematics achievement.

The independent variable, kindergarten readiness, was measured using the BRIGANCE Early Childhood Kindergarten Screen III core assessment which is comprised of three domains—physical development, language development, and academic skills/cognitive development—to categorize students as ready or not ready. The dependent variable, mathematics achievement, was measured using Measures of Academic Progress (MAP) Growth K-2 which is an interim assessment published by the Northwest Evaluation Association (NWEA). Each of these instruments are discussed in more detail in Chapter 3. Control variables in this study included students' demographic characteristics (race, gender, language), prior setting for early care and learning, and neighborhood socioeconomic status. These control variables were determined based on preliminary descriptive statistics and the review of literature in Chapter 2.

Scope

The scope of this study was limited to one large urban school district. Data collection was focused on grade 1 students enrolled in JCPS during the 2018-2019 school year. Achievement status outcomes on the MAP Growth K-2 mathematics assessment were analyzed from the Spring 2019 test session.

Limitations of the Study

The seminal work of Campbell and Stanley (1963) provides a framework for identifying sources of threat to internal and external validity in research studies. According to this framework, to establish internal validity the research design must include controls for extraneous variables that may explain the relationship or changes in the relationship between the independent variable and the dependent variable. To establish external validity, the research design must include consideration of limitations for the generalization of outcomes to other population groups or settings (Campbell, 1957). This framework was used to identify limitations of the current study that were important to the interpretation of the results.

In this study, the contribution of maturation effect to the social and academic developmental changes in early childhood may influence differences in the independent variable of kindergarten readiness and the dependent variable of grade 1 mathematics outcomes. However, previous research has consistently documented that the effect of schooling is larger than the effect of maturation on cognitive measures particularly in early elementary grades (Christian, Morrison, Frazier, & Massetti, 2000). While it is important to interpret findings with maturation effects in mind, the results of this study

can contribute to the understanding of achievement gaps and opportunity gaps in early childhood education.

Instrumentation could also provide a potential threat to internal validity. This study was secondary research which involves the use of data that was not collected specifically for research purposes (Hox & Boeijs, 2005). A disadvantage of this design for my study was limiting the variables included in the study to the existing dataset. For example, preliminary data and prior research indicate differences in kindergarten readiness by FRL eligibility status. However, student level data for this variable was not publicly available. This design also limited the control of instrumentation effect specific to the consistency of testing experiences across settings. Although instrumentation effect for this study cannot be fully eliminated, all school personnel responsible for the implementation of BRIGANCE were required to receive training for administering the screener and training on the collection and entering of data (Kentucky Department of Education, 2017a). Likewise, MAP Growth K-2 was administered by trained school personnel with an understanding of administration guidelines determined under the guidance of NWEA (Northwest Evaluation Association, 2011).

This study included data from all the district's elementary schools including magnet programs and schools. Although programs and schools vary in structure, it was an intentional decision to include the different types of programs represented in the district to examine the overall relationship between kindergarten readiness levels and later mathematics achievement. This approach along with providing descriptions of the study population and setting was intended to improve external validity by establishing

parameters for the generalization of outcomes only to grade 1 students in this school district during the 2018-2019 school year.

Definition of Key Terms

The key terms used in this study are defined as follows:

- Achievement Gap —the gap that “occurs when an outcome—for example, average test score or level of educational attainment—is higher for one group than for another group, and the difference between the two groups’ outcomes is statistically significant” (de Brey et al., 2019, p. 204).
- BRIGANCE Early Childhood Kindergarten Screener III—a tool to assess kindergarten readiness in five developmental areas: academic/cognitive development, language development, physical development, self-help and social-emotional development (Kentucky Department of Education, 2017a).
- Early Childhood Education (ECE) Programs—“systems of education and care for children from birth through eight years old” (Follari, 2015, p. 7)—includes several categories of services and programs that support the physical, cognitive, and social-emotional development of young children (Gullo, 2005).
- Ethnicity—“consists of two categories: Hispanic or Latinx and Not Hispanic or Latinx. Latinx may identify with any race” (U.S. Census Bureau, 2017).
- Free and Reduced Lunch (FRL) Eligibility—determined by Income Eligibility Guidelines based on household income and family size. Free meals are provided for students from households with income levels at or below 130 percent of the Federal poverty level. Reduced price meals are provided for students from

households with income levels between 130 and 185 percent of the Federal poverty level (U.S. Department of Agriculture, 2017).

- Gender—reported in the Kentucky Student Information System, Infinite Campus, as either of two biological sexes: male or female (Kentucky Department of Education, 2020).
- Interim assessments (or benchmark assessments)—“assessments administered during instruction to evaluate students’ knowledge and skills relative to a specific set of academic goals in order to inform policymaker or educator decisions at the classroom, school, or district level” (Perie, Marion, & Gong, 2009, p. 6).
- Kindergarten Entry (Readiness) Assessment—“an assessment that (a) is administered to children during the first few months of their admission to kindergarten; (b) covers all Essential Domains of School Readiness; (c) is used in conformance with the recommendation of the National Research Council reports on early childhood; and (d) is valid and reliable for the target populations and aligned to the Early Learning and Development Standards” (U.S. Department of Education, 2011).
- Kindergarten (or School) Readiness—“means each child enters school ready to engage in and benefit from early learning experiences that promote the child’s success” (Kentucky Department of Education, 2017b).
- Kindergarten Readiness Levels—designation of ready with enrichments, ready, or not ready as determined by scores in the domains of physical development, language development, and academic/cognitive development (Kentucky Department of Education, 2017c).

- Measures of Academic Progress K-2 Growth Assessment (MAP Growth K-2)—an interim assessment for reading and mathematics used to measure achievement status and track growth over time for students in grades K-2 (Northwest Evaluation Association, 2019a).
- Neighborhood Socioeconomic Status—a categorical designation of 1, 2, or 3 where 1 represents lower average socioeconomic status and 3 represents higher average socioeconomic status. The designation is determined by the average household income, average level of educational attainment, and racial composition of a census block (Orfield & Frankenberg, 2011).
- Opportunity Gap—disparities in opportunities available to different racial, ethnic, socioeconomic, and cultural groups (Carter & Welner, 2013).
- Prior Setting—A student’s setting(s) of early care and education services the year prior to kindergarten entry (704 KAR 5:070).
- Race—"a person’s self-identification with one or more social groups. An individual can report as White, Black or African American, Asian, American Indian and Alaska Native, Native Hawaiian and Other Pacific Islander, or some other race” (U.S. Census Bureau, 2020).

Organization of the Study

The remaining chapters of this study are organized as follows: Chapter 2 is a review of literature relevant to the background of the problem and the variables in this study. In Chapter 3, a discussion of the research study design is followed by a description of data collection and instrumentation procedures as well as data analysis procedures. In Chapter 4, the results of the statistical analysis were provided and discussed. Lastly, key

findings are summarized in Chapter 5 along with a discussion of implications for policy, practice, and future research.

CHAPTER 2: LITERATURE REVIEW

Early Childhood Education

Early childhood education is a general term that refers to the education and care of children across the developmental continuum from birth to eight years old (Follari, 2015). This term includes several categories of services and programs that support the physical, cognitive, and social-emotional development of young children (Gullo, 2005). A number of studies have provided empirical evidence supporting an association of high quality early childhood education programs with higher levels of kindergarten (or school) readiness and later academic achievement (Barnett, 2008; Reynolds, Magnuson, & Ou, 2010; Yoshikawa et al., 2013). However, past studies have also acknowledged persistent variations in access to high-quality early childhood education programs and subsequent kindergarten readiness outcomes that are often linked to demographic factors of the child and family as well as neighborhood socioeconomic status (Hatfield et al., 2015; Sampson, Morenoff, & Gannon-Rowley, 2002; Wrigley, 1989). Given the differences in early childhood education experiences and outcomes that exist across racial and class lines, it is important that research consider the link between opportunity gaps and achievement gaps (Barnett & Lamy, 2013; Carter & Welner, 2013).

In 1990, the National Education Goals Panel (NEGP) established six national goals for systemic educational improvement. The first of which was school readiness for all children entering kindergarten (NEGP, 1991a). While there was no national definition or standard for school readiness, the NEGP (1991b) identified five core developmental

domains of school readiness: physical and motor development, social and emotional development, approaches to learning, language development, and cognitive development. The NEGP (1991a) further stated the objective that “all disadvantaged and disabled children will have access to high-quality and developmentally appropriate preschool programs that help prepare children for school (p.4).” This goal and objective conveyed the importance of readiness for all students at school entry and acknowledged the potential for high-quality early care and education programs to provide more equitable early learning opportunities for children disadvantaged by social and economic factors. Similarly, the National Association of the Education of Young Children (NAEYC) (1995), proposed that a commitment to universal school readiness requires:

- (1) addressing the inequities in early life experiences so that all children have access to the opportunities that promote school success;
- (2) recognizing and supporting individual differences among children including linguistic and cultural differences; and
- (3) establishing reasonable and appropriate expectations of children’s capabilities upon school entry (p. 1).

As characterized over 30 years ago by the NEGP and NAEYC, school readiness is a multidimensional concept shaped by various factors including equitable access to programs, resources, and opportunities that address the distinct learning and developmental needs of children from different backgrounds.

In a recent analysis of school readiness across all 50 U.S. states, Lozano (2016) found that although states vary in how they define readiness, most states (including Kentucky) continue to align early learning standards and kindergarten readiness assessments to the five developmental domains established by the NEGP. An analysis of

state early learning standards revealed wide variability in document titles, patterns of organization, and terminology (DeBruin-Parecki & Slutzky, 2016); however, some common expectations of age-appropriate skills and levels of knowledge exist across developmental domains (Regenstein, Connors, Romero-Jurado, & Weiner, 2018). Likewise, states vary in the assessment practices and tools used to measure what students know and are able to do as they transition into kindergarten. However, reliable and valid kindergarten readiness assessments provide important information about children's developmental levels and learning trajectories across the core domains (Regenstein, Connors, Romero-Jurado, & Weiner, 2017). Given the absence of a national definition of school readiness and variability in state-level perspectives on early learning standards and assessment practices (Slutzky & DeBruin-Parecki, 2019), the following definition and key skills within each domain that comprise school readiness are specific to the context of this study.

In Kentucky, school readiness means each child enters school prepared for age-appropriate learning experiences aligned with the Kentucky Academic Standards for kindergarten students (Kentucky Department of Education, 2017b). Additionally, the Kentucky Early Childhood Standards (Kentucky Department of Education, 2013) establish benchmarks and indicators that identify progressive levels of knowledge and skills from birth through kindergarten entry in each of the five core developmental domains. These benchmarks and indicators represent typical age-specific milestones for the acquisition of knowledge and the development of functional skills. To measure students' developmental abilities at kindergarten entry, all school districts in the state of Kentucky administer a common screener—the BRIGANCE Early Childhood

Kindergarten Screen III (French, 2013; Kentucky Department of Education, 2017a). In this study, BRIGANCE is the instrument used to measure kindergarten readiness and to examine whether kindergarten readiness predicts grade 1 mathematics achievement.

BRIGANCE is a screening of children's skills in the areas of academic skills/cognitive development, language development, physical development, self-help skills, and social-emotional development. Screening results are used to identify which students are meeting age-appropriate developmental benchmarks as well as to determine whether additional evaluations for developmental delays or advance development may be warranted (French, 2013). Kentucky state regulation establishes minimum requirements for administration, data collection, reporting of results, and district use of student results. In accordance with 704 KAR 5:070, school districts must administer BRIGANCE to each incoming kindergartener prior to the 30th instructional day of the school year but no earlier than 15 days before the start of the school year. The regulation also requires that collected data is entered into the student information system by no later than October 15th of each school year. It is further mandated that this data is publicly reported by the Kentucky Department of Education at an aggregate level (i.e., school district, school readiness domain, student demographics, prior early learning settings). Guidelines for district use of the results clearly state that eligibility for school enrollment may not be determined by student results, but rather kindergarten entry is determined by local school board policy and KRS 158.031 which set age-requirements for school enrollment. Furthermore, the guidelines for district use also indicate that the results are an appropriate measurement to inform efforts to close the school readiness gap and to inform policy

decisions about early childhood education experiences prior to kindergarten entry (704 KAR 5:070; Kentucky Department of Education, 2017a).

According to the Kentucky Department of Education (2017b), BRIGANCE is aligned with Kentucky's definition of school readiness and the Kentucky Early Childhood Standards. Composite scores determined by the core assessment in three domains—physical development, language development, and academic skills/cognitive development—are used to measure kindergarten readiness levels. The physical development domain includes an assessment of gross motor skills and fine motor skills. Receptive language skills and expressive language skills are assessed in the language development domain. Whereas, literacy skills and mathematical concepts are assessed within the academic skills/cognitive development domain. Literacy skills include experience with books, visual discrimination, and phonological awareness. Mathematical concepts include matching quantities with numerals and sorting objects by size, color, and shape (French, 2013). This study considers whether this set of knowledge and skills predicts early elementary outcomes, particularly end-of-year grade 1 mathematics outcomes.

To support the analysis of formal screening results, parental reports of general background information and rating scales that provide a standardized measure of age-appropriate self-help skills and social-emotional development are included in the screening process. Information about self-help skills and social-emotional development related to eating, dressing, toileting, relationship with adults, play and relationship with peers, motivation and self-confidence, and prosocial skills and behaviors are obtained through the rating scales. General background information including where a child

received early care and education prior to kindergarten entry is also used to provide a context for understanding formal screening results (French, 2013). As discussed in the following section, characteristically children who have access to high-quality early childhood education programs meet kindergarten readiness benchmarks more often than students in low-quality settings. There is also variability in kindergarten readiness outcomes across the different types of program settings.

Prior Settings for Early Care and Education

In recent years, the RTT-ELC and state statute have required the development and implementation of a Quality Rating and Improvement System (QRIS) as a strategy to improve the quality of early childhood education programs that support the learning and development of infants, toddlers, and preschoolers (U.S. Department of Education, 2011; KRS 199.8943). A QRIS is a systematic approach to evaluate and communicate the level of quality of early care and education programs (Mitchell, 2005). According to information compiled by the QRIS National Learning Network (2017), QRIS have been implemented statewide in 38 states and are operating in counties/localities/regions of three additional states. Six states were in the planning phase, two states were piloting their systems, and one state did not have information about an existing QRIS. While the expansion of QRIS illustrates a growing interest in improving the quality of early care and education programs, most states use technical measures like QRIS participation rates or improvement in program ratings rather than outcomes for children like kindergarten readiness to evaluate progress and program effectiveness (Banghart, King, Partika, & Perkins, 2018).

In general, there is evidence to support that participation in state QRIS improves the overall quality of a program (Boller et al., 2015). Additionally, Jeon and Buettner (2015) found a direct association between QRIS levels and cognitive skills (i.e., literacy, language, and mathematical skills). The data showed that cognitive skills of children in the higher level QRIS programs were better than children in the lower level QRIS programs. The data also showed that high quality QRIS programs significantly moderate the negative relationship between cognitive skills and family socioeconomic status after controlling for child, home, and neighborhood factors. There remains, however, a need to further examine the relationship between QRIS and child outcomes (Hong, Howes, Marcella, Zucker, & Huang, 2015).

Participation in Kentucky's QRIS is mandatory for all early care and education programs that receive public funding including private child care centers, Head Start, and public preschool (922 KAR 2:270, 2018). Private child care centers include licensed residential or non-residential facilities and certified care in a provider's home. Head Start programs operate under federal guidelines and regulations and includes programs operating at the same site as a private child care or public preschool, or programs that operate as a self-contained site. Head Start programs are federally funded and provide services to students from households with income levels below 100% of the Federal poverty level while also providing preferential status for students with disabilities or other needs. Kentucky's public preschools are state-funded and provide services to students from households with income levels at or below 160 percent of the Federal poverty level and students with disabilities regardless of household income. Public preschools function under the administration of local school districts and the Kentucky

Department of Education (Governor's Office of Early Childhood, n.d.). As discussed in the forthcoming section, kindergarten readiness outcomes differ across these three models of early care and education programs.

All Kentucky school districts are required by state regulation to collect information for each student about the prior setting(s) of early care and education services the year prior to kindergarten entry (704 KAR 5:070). Prior setting data includes certified and non-certified early care and education settings categorized as state-funded preschool, Head Start, child care, home, or other. The category regarded as other includes care provided outside of the home by a family member, private sitter, or nanny (Kentucky Department of Education, 2017a). Since 2013, the Kentucky Department of Education (2019b) has annually reported a summary of BRIGANCE outcomes for the state and each school district by prior setting. As described below, these data generally indicate that kindergarten readiness outcomes vary across prior settings.

Figure 2 reports data from 2013 to 2018 that indicates the percent of students in JCPS who were identified as kindergarten ready by prior setting the year before kindergarten entry. The data shows that from 2013-2014 and 2016-2018, at least 70% of students in private child care settings demonstrated kindergarten readiness. In 2015, 66.9% of students in private child care settings were identified as kindergarten ready. During these same years, the percent of students identified as kindergarten ready ranged from 47.4% to 60.5% for students in state-funded preschools and 47.8%-60.5% for students in Head Start. In comparison, the range was 27.3% to 35.8% for students in home care and 54.1% to 62% for students in other settings.

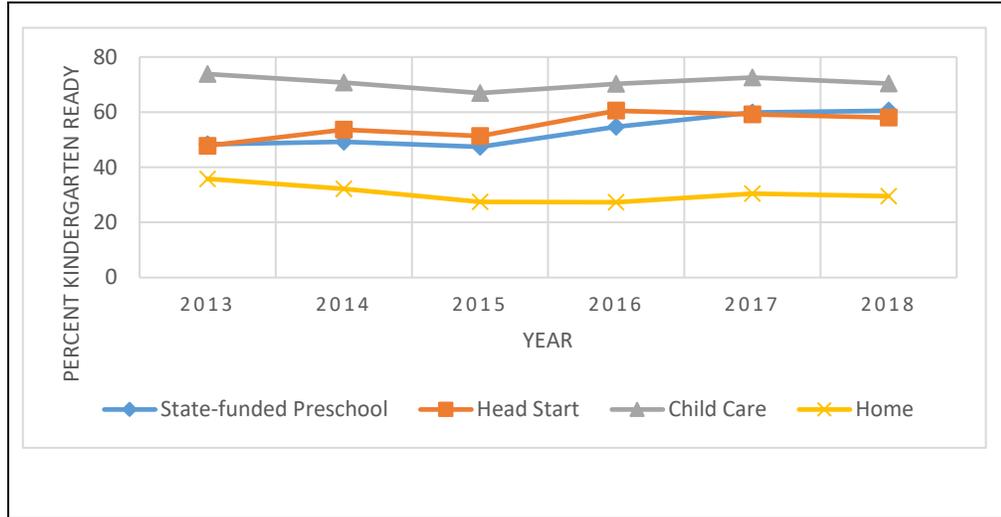


Figure 2. Kindergarten readiness by prior setting from 2013-2018 for JCPS. Adapted from Kentucky Department of Education (2019b) Open House Data.

Although the trend has some variation from year to year, more of the students in private child care settings meet kindergarten readiness benchmarks when compared to all other certified and non-certified settings. Students in settings categorized as other generally have a marginally higher percent of students identified as kindergarten ready when compared to state-funded preschools and Head Start. Students in home care the year prior to kindergarten entry consistently have the lowest percent of students who meet kindergarten readiness benchmarks when compared to all other certified and non-certified settings. As discussed in the following section, participation in high-quality early childhood education programs has short-term benefits like kindergarten readiness but research also provides evidence of long-term educational benefits for the child and economic benefits for society.

Short- and Long-Term Benefits of High-Quality Programs

Scholarly research has provided empirical evidence supporting an association of high-quality early childhood education programs with higher levels of school readiness (Barnett, 2008; Yoshikawa et al., 2013). Three seminal longitudinal studies provide evidence of both short- and long-term benefits of participation in high-quality early childhood education programs particularly for children at-risk due to economic disadvantage (Campbell, & Ramey, 1995; Reynolds, 1997; Schweinhart, Barnes, & Weikart, 1993). These longitudinal studies document evidence that high-quality early care and education programs have practical significance in terms of academic measures, particularly for children living in poverty, as well as high levels of cost effectiveness.

The High/Scope Perry Preschool Study, the Abecedarian Study, and the Chicago Child-Parent Center Study were all implemented in the 1960s and 1970s to examine the effects of early childhood education programs from early childhood into adulthood (Schweinhart, 2016). The High/Scope Perry Preschool Study (Schweinhart et al., 1993) began in 1962 and followed 123 African American children from low-income families from the age of three into adulthood. Students were randomly assigned to either a program group or a no-program group. The program group participated in a high-quality part-day preschool program and the no-program group did not participate in a preschool program. Participants were followed annually from the ages of 3 to 11 in addition to follow-up studies at ages of 19, 27, and 39-41. Findings from the study consistently indicated significant differences between the program group and the no-program on multiple measures including various academic assessments and high school graduation rates. Findings at the age of 27 continued to indicate significant differences between the

groups. Levels of education, income, and home ownership were significantly higher among the program group. In contrast, the no program group had significantly higher rates of arrests and higher rates of participation in social services programs (Schweinhart, & Weikart, 2002).

The Abecedarian Study (Campbell, & Ramey, 1995) followed four cohorts of participants born between 1972 and 1977. The study participants were from impoverished households and 98% were African American. This study differed from the other studies because it included participants who participated in a full day preschool program from infancy through kindergarten entry at age 5. The study design, however, included random assignment to three groups: preschool treatment followed by early elementary treatment, preschool treatment only, and early elementary school treatment only. Findings from the study indicated significant differences on measures of intellectual development from the age of 18 months to 54 months for children receiving preschool treatment compared to children not receiving preschool treatment. Children in the preschool treatment group in comparison to the early elementary school treatment group continued to demonstrate significantly higher levels of performance on academic assessments of reading and mathematics. These children also were less likely to receive special education services and had lower rates of retention. Findings at the age of 21 continued to indicate significant differences for children receiving preschool treatment compared to children who did not receive preschool treatment. Preschool treatment was associated with increased levels of post-secondary education and continued differences in academic skills. At this point in the study, there were not significant economic differences (Campbell, Ramey, Pungello, Sparlin, Miller-Johnson, 2002).

The Chicago Child-Parent Center (Reynolds, 1994) opened in 1967 as a school-based program supported through Title 1-ESEA funds. The study, however, began with a cohort of students born in 1980. Participants included 1,539 children, 93% of whom were African American and lived in high poverty neighborhoods. Children attending the Child-Parent Center preschool program participated in half-day preschool at the ages of 3 and 4, half-day kindergarten at the age of 5, and received additional interventions for the first three years of elementary school. The comparison study included children attending full-day kindergarten programs, and some of these students also received additional intervention services targeting children in low-income communities. Like the other studies, findings indicate higher levels of academic performance and social behavior in preschool as well as higher levels of educational attainment and lower levels of criminal behavior in adulthood for the preschool group in comparison to the group that did not attend preschool (Reynolds, Temple, & Ou, 2010; Reynolds, Temple, Robertson, & Mann, 2002).

While the discussion of the aforementioned studies has focused on the enduring effects of high-quality early childhood education programs for children living in poverty, subsequent cost-benefit analysis also suggests economic benefits to society. For example, Temple and Reynolds (2007) found evidence from these three studies that economic returns from investments in high-quality early childhood education programs exceed investments in other educational interventions, including intervention programs and services during elementary school. Ansari and Winsler (2016) contend that given the investment of public funding in early childhood education programs, it is important to examine the associations between prior setting and outcomes at kindergarten entry

through the transition into early elementary school. The current study considered whether kindergarten readiness, taken together with prior setting and other factors, predicts mathematics outcomes at the end of the first grade year.

As discussed in the forthcoming section, many children from low-income, ethnically, and linguistically diverse backgrounds still lack access to early care and learning experiences that promote school readiness and support later academic achievement through the development of early academic skills and behaviors (Nores & Barnett, 2014; Winter & Kelley, 2008). Previous studies have provided evidence of variation in access to high-quality early childhood education programs based on race and social class as well as exposed differences in access associated with neighborhood variables of concentrated affluence and concentrated disadvantage (Hatfield et al., 2015; Sampson et al., 2002; Wrigley, 1989).

Achievement Gaps and Opportunity Gaps

Evidence from large, nationally representative samples indicate that race and income-related readiness gaps at kindergarten entry have slightly narrowed over time (Magnuson & Duncan, 2016). However, the same datasets demonstrated widening gaps in access and participation in high-quality early childhood education programs associated with socioeconomic status (Bassok, Finch, Lee, Reardon, & Waldfogel, 2016). While the magnitude of differences in access, participation, and readiness vary with the data source and assessment tool (Joshi, Geronimo, & Acevedo-Garcia, 2016), there is general agreement that substantive differences persist across these measures of equity in early childhood education (Magnuson & Waldfogel, 2016; Reardon & Portilla, 2016). Nores and Barnett (2014) contend: “These inequalities [in school readiness] are long standing,

and there has been little improvement over the last decade in access to quality pre-K and other programs” (p. 26). In recent research, variations in availability and quality of early childhood education programs are found to be associated with neighborhood-level socioeconomic status (Bassok & Galdo, 2016; Yazejian & Iruka, 2015).

Research demonstrates that structural advantage or disadvantage of a neighborhood influences access to resources that support child development. For example, Leventhal and Brooks-Gunn (2000) indicate “availability, affordability, and quality of several types of [institutional]resources in the community” (p. 322) are associated with neighborhood-level socioeconomic status. Studies that focus on variations in access to quality early childhood education programs have found that level of neighborhood advantage or disadvantage contribute to disparities in developmental outcomes including school readiness (Burchinal, Nelson, Carlson, & Brooks-Gunn, 2008; Leventhal, Dupéré, & Shuey, 2015; McCoy, Connors, Morris, Yoshikawa, & Friedman-Krauss, 2015). In a descriptive study of national trends in the association between skills and behaviors at school entry and neighborhood socioeconomic status, Wolf, Magnuson, and Kimbro (2017) found substantive differences across neighborhoods of differing poverty levels. Furthermore, Morrissey and Vinopal (2018b) found that neighborhood socioeconomic status was predictive of achievement outcomes in preschool and early elementary grades. These findings provided evidence that children living in high poverty neighborhoods had poorer achievement outcomes compared to children living in moderate or low-poverty neighborhoods. Although differing in ways, together these studies suggests that neighborhood socioeconomic status may be an important factor in the study of early learning outcomes.

Previous studies of the effects of neighborhood socioeconomic status on child development emphasize place-based disparities in environmental and social risks that jeopardize a child's mental and physical health as well as cognitive abilities (Mihn, Muhajarine, Janus, Brownell, & Guhn, 2017). Past studies have also yielded some important insights into place-based variations in the availability and quality of institutions and institutional resources (Leventhal et al., 2015). In a national study, Bassok, Fitzpatrick, and Loeb (2012) found a non-linear relationship between the median income of a neighborhood and the availability of early care and education programs. The findings from this study document the highest levels of availability and quality in the most affluent neighborhoods; however, higher levels of availability and quality are evident in impoverished neighborhoods compared to low- and middle-income neighborhoods. The overall relationship between the median income of a neighborhood and the availability and quality of programs did not change with the added variable of racial composition. These findings align with a recent analysis of Child Care Development Fund plans (CCDF), in which Banghart et al. (2018) found that state-level policies prioritized funding to increase availability and quality of early education services in areas with concentrations of poverty and unemployment. In Kentucky, census data and state unemployment rates as reported by the Bureau of Labor Statistics are used to identify and develop targeted plans for geographic areas with concentrations of poverty and unemployment (Kentucky Cabinet for Health and Family Services, 2016).

In general, there is evidence of the implementation of policies and funding to improve access to high-quality early childhood programs in the most impoverished areas (United States Office of Child Care, 2015; U.S. Department of Health and Human

Services, 2014). However, studies indicate that opportunity gaps and associated achievement gaps persist in terms of race and class and in the broader context of neighborhood advantage and disadvantage (Barnett & Lamy, 2013; Hatfield et al., 2015). Likewise, previously discussed descriptive statistics of kindergarten readiness outcomes seemingly document early achievement gaps in terms of race, class, and prior setting the year before kindergarten entry (Kentucky Department of Education, 2019b). Taken together, these descriptive statistics and research suggest that prior setting and neighborhood socioeconomic status may be a useful proxy to identify and respond to opportunity gaps that are associated with achievement gaps at school entry. In this study, I investigated the extent to which kindergarten readiness, student demographic characteristics, prior setting, and neighborhood socioeconomic status predict grade 1 mathematics outcomes. The following section on the assessment of academic performance establishes the basis for the use of interim assessments to measure mathematics outcomes—achievement status and growth from kindergarten entry through grade 1.

Assessment of Academic Performance

Schools and districts use comprehensive assessment systems based on multiple measures to inform decisions about teaching and learning (Brookhart, 2015). In a framework developed by Perie, Marion, Gong, and Wurtzel (2007), a comprehensive assessment system is comprised of three assessment types—summative, interim, and formative—that together provide data to support more effective classroom instruction, inform programs and policies, and ultimately improve student learning outcomes. Within this framework, these researchers distinguish between the three types of assessments

based on their design, purpose, primary audience, and intended uses of information.

Although each of the three assessment types included in this framework may fulfill more than one purpose, Perie, Marion, and Gong (2009) emphasize that it may be necessary to use multiple assessments to satisfy the primary and distinct information needs of different role groups.

Summative assessments characteristically have an evaluative purpose and are designed to measure student achievement of content standards at the end of a course, grading period, or school year. Results from summative assessments are typically aggregated at the school, district, or state level to measure overall academic achievement. Results may also be disaggregated by student characteristics including race or ethnic background, gender, FRL eligibility, disability status, or language to make comparisons between groups of students. Data are often shared publicly to hold programs accountable for student achievement, to evaluate the effectiveness of programs, and to inform policy decisions. In contrast, formative assessments generally have an instructional purpose and are designed to measure student understanding during the learning process. Results of formative assessments are primarily used by the classroom teacher to track student progress toward specific standards and to modify instruction to meet students' learning needs (Hamilton et al., 2009; Perie et al., 2007). Seminal research by Black and William (1998) and the subsequent research of Hattie and Timperly (2007) and Kingston and Nash (2009) found that formative classroom assessments are positively correlated with student learning.

Comparatively, interim assessments are designed to “evaluate students’ knowledge and skills relative to a specific set of academic goals and are designed to

inform decisions at both the classroom and beyond the classroom level such as at the school or district level” (Perie et al., 2007, p.1). By design, some interim assessments are aligned with state content standards and are used to predict student performance on end-of-year accountability assessments. Like formative assessments, interim assessments can serve an instructional purpose at the classroom level. However, formative classroom assessments like anticipation guides, response cards, and exit slips are integrated into the context of the lesson to provide information about student learning during the day-to-day instructional process (Conderman & Hedin, 2012). Whereas, interim assessments are administered multiple times at regular intervals during the school year (e.g., end of a grading cycle, monthly, quarterly) to provide information about student achievement and growth over time relative to grade-level or course standards. Unlike formative assessments, results of interim assessments may be aggregated to serve an evaluative purpose and to inform curricular and program decisions at the school or district level (Hamilton et al., 2009).

Although each of these three assessment types has advantages and limitations, taken together they are important to improving classroom practices, instructional programs, and policies that influence children’s educational experiences. Interim assessments, which are particularly useful for understanding the aggregate achievement and growth of students over time as well as identifying differences in achievement and growth between groups of students, will be the focus of this study. In recent years, educational researchers have documented the increasing use of interim assessments and the effects on student achievement in policy briefs, technical papers, and research journals. In these sources, researchers used the term benchmark assessments almost

interchangeably to refer to interim assessments as they are defined in this study. Although both terms are used in this chapter to maintain consistency with the original sources, interim assessments is the umbrella term used throughout this study. The next section considers the use of interim assessments as a tool to predict and improve student performance and to close achievement gaps that exist across racial and class lines.

Interim Assessments

As the following review of experimental studies indicate, the research thus far has yielded mixed findings on whether the use of interim assessment data is related to improved academic outcomes as measured by state accountability tests. Henderson, Petrosino, Guckenburger, and Hamilton (2007a) used a quasi-experimental design to examine the impact of benchmark assessments on student achievement in high-poverty middle schools. Benchmark assessments were administered quarterly to monitor student progress and predict student performance on an end-of-year state accountability test, the Massachusetts Comprehensive Assessment System (MCAS). Twenty-two middle schools participating in a pilot program for benchmark assessments in mathematics were compared to 44 schools with similar baseline mathematics scores and like demographics. The researchers found no statistically significant increases or decreases in eighth-grade mathematics achievement in the program or comparison schools. While these findings suggest that the implementation of benchmark assessments had no effect on student achievement, the researchers acknowledge that the use of student level data rather than school level data may have revealed differential effects between student groups. Yet, the researchers repeated the study the following year using the same research design with the

same schools and again found no statistically significant difference between program and comparison schools (Henderson, Petrosino, Guckenbug, & Hamilton, 2007b).

Carlson, Borman, and Robinson (2011) examined the impact of a one-year data-driven reform initiative implemented in over 500 schools in 59 districts by the Center for Data-Driven Reform in Education (CDDRE) at John Hopkins University. Participating districts, with the support of CDDRE consultants, implemented and interpreted the results of quarterly benchmark assessments for grades 3-8 in reading and mathematics. Findings from the study indicated statistically significant improvement in student mathematics achievement on the state-administered achievement test, but improvements in student reading achievement were not statistically significant. Consistent with previous studies (Henderson et al., 2007a; May & Robinson, 2007; Quint, Sepanik, & Smith, 2008), the effect sizes of benchmark assessments on student achievement were generally small in the first years of implementation. Findings from a four-year follow-up study to the CDDRE initiative indicated significant positive effects on both reading and mathematics for grades 5 and 8 (Slavin, Cheung, Holmes, Madden, & Chamberlain, 2013).

In a cluster randomized experiment, Corday, Pion, Brandt, Molefe, and Toby (2012) examined the impact of the Measures of Academic Progress (MAP) interim assessments on reading performance in grades 4 and 5. The researchers assigned classrooms from 32 elementary schools in five Illinois districts to the treatment condition or the control condition. MAP interim assessments for reading and language use were administered three times a year to the treatment group and the results were provided to teachers to monitor student progress toward reading standards on the state accountability test, the Illinois Standards Achievement Test (ISAT). Teachers also received resources

and training in differentiated instruction from the Northwest Evaluation Association (NWEA). After the second year of implementation, reading performance as assessed by ISAT was not statistically different between classrooms assigned to the treatment condition and classrooms assigned to the control condition. Additionally, findings for students grouped by characteristics including prior reading achievement, gender, socioeconomic status, race/ethnicity, English proficiency, and disability status were mixed and did not provide clear evidence of an overall impact for any group of students. At grade 4, the treatment condition had a statistically significant differential effect on ISAT reading scores for students whose prior reading achievement was low and whose prior reading achievement was high. There were no statistically significant differential effects between student groups at grade 5 on ISAT reading scores.

Taken together, these studies provide mixed evidence about the relationship between interim assessment use and subsequent academic achievement across grade levels, notably 3-8. Although the impact of interim assessments on achievement in general is an important area of inquiry, questions remain unanswered regarding the use of interim assessments in early elementary grades and the impact on achievement gaps. The following studies contribute to the growing body of general research on the use of interim assessments to improve overall student achievement including grades K-2 and address gaps in the literature about achievement differences between student groups.

In a large-scale randomized experiment, Konstantopoulos, Miller, and van der Ploeg (2013) carried out an extensive study of the impact of Indiana's system of interim assessments on reading and mathematics achievement and the effects on achievement gaps. Participating schools used Wireless Generation's mCLASS for grades K-2 and

CTB/McGraw-Hill's Acuity for grades 3-8 to collect data and progress monitor during the school year. At the end of the year, student performance in grades K-2 were measured by Terra Nova scores and student performance in grades 3-8 were measured by ISTEP, the state accountability test. The researchers compared student achievement in grades K-8 between 31 treatment schools and 18 control schools and found that the impact of interim assessments on student achievement in both reading and mathematics were positive across grade levels. However, the magnitude of the effects was not statistically significant in early elementary grades K-2 for reading or mathematics. Statistically significant effects were indicated for both reading and mathematics in grades 3-8. Generally, the effects were larger for mathematics than for reading across all grade levels. While these results were not statistically significant in grades K-2, overall there was a consistent positive effect on mathematics. My study builds on this research base and uses interim assessment data to examine early mathematics achievement and growth.

Konstantopoulos, Li, Miller, and van der Ploeg (2016) also examined the effects of interim assessments across the achievement continuum with a focus on the benefits for students in the lower tail of the achievement distribution. The results of the study indicated no significant treatment effects across the achievement continuum in reading or mathematics in grades K-2. However, there were indications of positive treatment effects and in some grade levels significant effects in both reading and mathematics for grades 3-8. Although there was some indication of stronger effects for students in the lower tail of the achievement distribution, the results were inconsistent, and the researchers were unable to conclude that interim assessments can reduce performance differences between lower and higher achievers. These findings suggest the need for additional research to

examine interim assessment data for differences in performance related to prior achievement. In this study, I considered whether kindergarten readiness levels together with other factors predict subsequent mathematics outcomes in early elementary school.

Lastly, Konstantopoulos, Li, Miller, and van der Ploeg (2017a) used data from this experiment to examine the effects of interim assessments on gaps in achievement linked to race and socioeconomic status in grades K-6. The researchers examined main effects and interaction effects for student ethnicity, socioeconomic status, gender, and school composition. In general, there was little evidence of consistent patterns of differential benefits for students disadvantaged by factors linked to race or socioeconomic status. Utilizing data from the following 2010-2011 school year, Konstantopoulos, Li, Miller, and van der Ploeg (2017b) continued to examine the effects of interim assessments on achievement gaps. They investigated the moderating effects of socioeconomic status, race, level of prior achievement, gender school composition, and urbanicity on interim assessments in mathematics and reading achievement. In grades K-2, the main effects of interim assessments were negative and significant in both reading and mathematics. In contrast, the main effects were not significant for mathematics or reading in grades 3-8. Although the study provided clear evidence of differences in student achievement associated with race, socioeconomic status, and gender, there were mixed results for the interaction effects of interim assessments with socioeconomic status, race, and gender. Overall, Konstantopoulos et al. (2017b) concluded that evidence from this study does not clearly support that interim assessments influence achievement gaps.

In general, literature focused on the influence of interim assessments on achievement status and achievement gaps revealed mixed findings indicating the need for additional studies before trends and generalizations may emerge. Additionally, a limited number of studies have addressed the use of interim assessments in early elementary grades K-2. My study builds on previous research and uses interim assessment data to examine grade 1 end-of-year mathematics achievement. My study also extended previous research and used interim assessment data to investigate the relationship between achievement gaps and opportunity gaps. As previously discussed in detail, variations in access to high-quality early childhood education programs are associated with achievement differences at kindergarten entry. Interim assessment data provides an opportunity to understand whether these achievement differences persist, diminish, or remain the same in early elementary school. As discussed in the forthcoming section, previous research establishes the importance of understanding achievement status in connection to prior level of achievement (Betebenner, 2011; Rothstein, Jacobsen, & Wilder, 2008).

Achievement Status and Growth

Within the domain of educational accountability, there are two types of models used to hold schools, districts, and states accountable, namely: status models and growth models (Figlio & Loeb, 2011). Status models use one data point as a measure of the academic performance of a student or group (e.g., percent of students meeting grade-level proficiency on an end-of-year state assessment). In contrast, growth models use multiple data points over time to provide a more comprehensive measure of the academic performance of a student or group (e.g., comparing current achievement to prior

achievement) (Castellano & Ho, 2013). Taken together, status measures and growth measures provide incentive for districts and schools to attain high levels of achievement and high levels of growth (Ladd & Zelli, 2002). In this study, I will consider both measures—mathematics achievement status at the end of grade 1 and growth description based on prior level of achievement as indicated by kindergarten readiness and grade 1 beginning of the year mathematics achievement.

Status models measure student performance relative to a set proficiency level, where proficiency is defined by meeting a target score on an assessment of grade-level standards. Districts and schools are held accountable for the level of average achievement and typically includes aggregation of data by school, grade-level, and student demographic characteristics. Arguably, the focus of attention in a status model is on aggregate performance level; however, this model sets the same performance target for each student and for all groups of students. Status models provide an incentive for districts and schools to increase the overall percentage of students who meet a given proficiency level, but a perceived disadvantage of the model is that it does not consider the starting point for each student (Figlio & Loeb, 2011; Ladd & Lauen, 2009).

Growth models measure student performance relative to prior level of achievement rather than a common performance threshold for all students. Under the growth model system, districts and schools are held accountable for differentiated outcomes determined by actual achievement gains compared to expected achievement gains based on a student's starting point. Proponents of this model argue that where students start influences where they end; therefore, growth measures provide a better evaluation of school effect on student performance. By contrast, a perceived disadvantage

of the model is that it does not necessarily provide incentive for districts and schools to raise the performance of all students to a target proficiency level (Figlio & Loeb, 2011; Ladd & Lauen, 2009).

There is general agreement in the literature that status measures alone are inadequate as an indicator of school quality and school performance (Goldschmidt et al., 2005; Choi, Goldschmidt, & Yamashiro, 2005; Novak & Fuller, 2003). Although status measures hold schools accountable for a minimum level of achievement for all students, growth measures are a better indicator of student learning (O'Malley, Murphy, McClarty, Murphy, & McBride, 2011) and provide a more equitable comparison between schools and districts when student characteristics like prior performance are taken into consideration (Goldschmidt, Choi, & Beaudoin, 2012). Betebenner (2009), in acknowledging the criticisms of the use of status measures for accountability, states: "Though appropriate for making judgments about the achievement level of students at a school for a given year, they [status measures] are inappropriate for judgments about educational effectiveness" (p. 42). Integral to this discussion is recognition that status models are unconditional achievement models and growth models are conditional achievement models. Status models hold schools, districts, and states accountable for all students meeting a defined level of achievement with no consideration of prior achievement or other conditions. Alternatively, growth models are structured to measure the amount of academic progress students make in terms of prior achievement (Betebenner, 2009).

Castellano and Ho (2013) classify growth models according to the fundamental interpretations that their growth metrics can support—growth description, growth

prediction, and value-added. In general, growth description models focus on the direction and magnitude of observed growth in student performance. Data from growth description models are most often analyzed to primarily describe and monitor changes in aggregate student performance. Like growth description models, value-added models focus on observed growth in student performance. However, data from value-added models are analyzed to determine the factors that contribute to the direction and magnitude of observed growth in student performance. Conversely, growth prediction models focus on expected growth in student performance. Typically, the results from growth prediction models are used to project and/or set expectations for future student performance (Castellano & Ho, 2013).

Although growth-based models present an alternative or complement to status-based models for educational accountability, as Castellano and Ho (2013) point out there are a variety of approaches to the measurement of growth and interpretation of the results. Previous research has compared growth models particularly to provide guidance on their use for monitoring school performance and evaluating school effectiveness; however, Goldschmidt et al. (2012) caution that “causal claims may still not be warranted” (p. 10). Similarly, in discussion of K-12 educational accountability systems, Linn (2008) contends that assessment results are most accurately considered descriptive information about students and schools rather than a basis for causal inferences. He suggests that student achievement measures and demographic characteristics are potentially important for the identification of schools where an analysis of organizational and instructional practices is needed. He also regards this descriptive information as a source of hypotheses for additional research.

Although status models and growth models capture different data, taken together these models can provide a more complete description of student performance. Blank and Cavell (2005) proposed that used together status measures and growth measures can answer questions like: Which groups of students are not reaching the defined target and what can be done to improve their performance? How does the progress of one subgroup of students compare to that of another? In this study, the use of interim assessment data allowed for the investigation of grade 1 mathematics achievement of students from varying backgrounds comparative to prior levels of achievement, specifically kindergarten readiness and grade 1 beginning of the year mathematics achievement.

Summary

In general, the reviewed research indicated that high-quality early learning experiences make it more likely for students to meet age-appropriate developmental benchmarks. Yet, preliminary descriptive statistics indicated that achievement gaps by race, social class, and prior setting are evident at kindergarten entry. In discussion of early childhood education programs, Ansari and Winsler (2016) emphasized that previous studies (Duncan & Magnuson, 2013; Gormley, Gayer, Phillips, & Dawson, 2005; Loeb, Bridges, Bassok, Fuller, & Rumberger, 2007; Raikes, Vogel & Love, 2013) document differential program effects for children from different backgrounds. For this reason, they contend that “research should go beyond the examination of average program effects and instead examine how children from different backgrounds respond to different programs” (p. 71). Moreover, the opportunity gap framework purports that equitable educational opportunities are necessary to ensure equitable educational outcomes. Likewise, the reviewed research indicated that neighborhood advantage and

disadvantage influence access to resources and the quality of early care and learning options. Furthermore, Morrissey and Vinopal (2018b) contend that “it is unclear to what degree associations between neighborhood disadvantage and outcomes persist into elementary school” (p.182). Although the general influence of early childhood education programs was examined in prior studies, this study furthered the discussion with the inclusion of prior setting and neighborhood socioeconomic status as a proxy for opportunity gaps that may influence the achievement gap at kindergarten entry. This study also considered whether the set of knowledge and skills that define kindergarten readiness along with prior setting and neighborhood socioeconomic status predict mathematics outcomes at the end of grade 1 for students from different backgrounds.

CHAPTER 3: METHODOLOGY

In this study, a quantitative methodology with a correlational research design was used to investigate the relationship between kindergarten readiness and subsequent mathematics achievement. More specifically, the purpose of this study was to examine whether kindergarten readiness predicts grade 1 end-of-year mathematics achievement controlling for students' demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status. Descriptive statistics provided information about the participants in the study including student-level demographic characteristics (i.e., race, gender, language, prior level of achievement as indicated by grade 1 beginning of the year mathematics achievement) and contextual factors (i.e., prior setting for early care and education, neighborhood socioeconomic status). Multiple regression analysis was used to determine how well kindergarten readiness taken together with these characteristics and factors predict subsequent mathematics achievement at the end of grade 1.

Research Questions and Measurement of Variables

The following research question was investigated in this study:

RQ1: Does kindergarten readiness predict grade 1 end-of-year mathematics achievement, controlling for students' demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status?

The following were my hypotheses regarding the research question that guides this study:

H1₀: There is no relationship between kindergarten readiness and grade 1 end-of-year mathematics achievement.

H1₁: There is a positive relationship between kindergarten readiness and grade 1 end-of-year mathematics achievement.

Table 1 provides an overview of the measurement of each variable that was included in this study. The independent variable, kindergarten readiness, was measured using the BRIGANCE Early Childhood Kindergarten Screen III core assessment which is comprised of three domains—physical development, language development, and academic skills/cognitive development—to categorize students as ready or not ready. The dependent variable, mathematics achievement, was measured using MAP Growth K-2 which is an interim assessment published by NWEA. Student demographic characteristics included parent/guardian report of race/ethnicity, gender, and prior setting for early care and learning. Neighborhood socioeconomic status was measured by the average household income, average level of educational attainment, and racial composition of a census block.

Table 1

Measurement of Independent and Dependent Variables

Variables	Measurement of Variable	Definition	Level of Measurement
Kindergarten Readiness	BRIGANCE Early Childhood Kindergarten Screen III Determined by the core assessment	A composite score determined by the core assessment is a measurement of a child’s performance in three domains—physical development, language development, and academic skills/cognitive development (French, 2013).	Nominal Ready (includes ready with enrichments) Not Ready (Dummy coded variable; Reference group—Ready)
Race/Ethnicity	Enrollment Data Parent/Guardian report of race/ethnicity	Race is self-identification with one or more of the following groups: White-A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.	Nominal White (non-Latinx) Black or African American Latinx Asian

		<p>Black or African American-A person having origins in any of the Black racial groups of Africa.</p> <p>Asian- A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.</p> <p>Native Hawaiian or Other Pacific Islander- A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands (U.S. Census Bureau, 2020).</p> <p>Ethnicity consists of two categories: Hispanic or Latinx and Not Hispanic or Latinx. Latinx may identify with any race (United States Census Bureau, 2017).</p>	<p>Two or more races</p> <p>(Dummy coded variable; Reference group—White (non-Latinx))</p>
Gender	<p>Enrollment Data</p> <p>Parent/Guardian report of gender</p>	<p>Gender is reported in the Kentucky Student Information System, Infinite Campus, as either of two biological sexes: male or female (Kentucky Department of Education, 2020).</p>	<p>Nominal</p> <p>Male</p> <p>Female</p> <p>(Dummy coded variable; Reference group—Male)</p>
Prior Setting for Early Care and Learning	<p>BRIGANCE Early Childhood Kindergarten Screen III</p> <p>Parent/Guardian report of prior setting(s)</p>	<p>A student’s setting(s) of early care and education services the year prior to kindergarten entry (704 KAR 5:070).</p>	<p>Nominal</p> <p>State-funded preschool</p> <p>Head Start</p> <p>Private child care center</p> <p>Home</p> <p>Other</p> <p>(Dummy coded variable; Reference group—Private child care center)</p>
Neighborhood Socioeconomic Status	<p>Determined by the average household income, average level of educational attainment, and racial composition of a census block</p>	<p>A categorical designation of 1, 2, or 3 where 1 represents lower average socioeconomic status and 3 represents higher average socioeconomic status (Orfield & Frankenberg, 2011).</p>	<p>Nominal</p> <p>Category 1</p> <p>Category 2</p> <p>Category 3</p> <p>(Dummy coded variable; Reference group—Category 2)</p>
Grade 1 Mathematics Achievement	<p>Northwest Evaluation Association (NWEA) MAP Growth K-2 interim assessment</p> <p>Composite Scale Score</p>	<p>Achievement status as measured by an assessment aligned to the Common Core State Standards (CCSS) for mathematics (Northwest Evaluation Association, 2019b).</p>	<p>Interval</p> <p>Equal-interval vertical scale, Rausch unIT (RIT) scale, with a range of scores from 100 to 310.</p>

Research Study Design

Multiple regression analysis was used to investigate the degree to which kindergarten readiness predicts subsequent mathematics achievement in grade 1. For the purpose of this study, the dependent variable was measured using students' grade 1 end-of-year MAP mathematics achievement scores. This analysis also considered whether the predictive relationship between kindergarten readiness and mathematics achievement is improved by the inclusion of students' demographic characteristics (i.e., race, gender, language, prior level of achievement as indicated by grade 1 beginning of the year mathematics achievement) and contextual factors (i.e., prior setting for early care and learning, neighborhood socioeconomic status). According to Osborne (2000), multiple regression is an appropriate design for prediction or explanation of the relationship between multiple predictor variables (independent variables including control variables) and an outcome (dependent variable). Furthermore, from multiple regression analysis an equation can be generated to model this relationship and predict outcomes within the population. The objective of this study was the identification of variables that best predict grade 1 end-of-year mathematics achievement and the development of a prediction equation that represents this relationship. Understanding the predictors of grade 1 mathematics achievement at kindergarten entry would provide validation for the implementation of equitable supports and learning opportunities in early childhood education programs and early elementary school.

This was a correlational study that is a nonexperimental form of research. In nonexperimental research, the study of the relationship between variables does not include the manipulation of the independent variable nor the random assignment of

participants to control and experimental groups (Ary, Jacobs, Sorensen, & Walker, 2013). The manipulation or random assignment of students to different levels of kindergarten readiness is not possible and for this reason a nonexperimental approach is appropriate for this study. In a correlational study, the relationship between the independent variable(s) and the dependent variable is measured using a correlational statistic and described in terms of the magnitude and direction (positive or negative) of the association (Creswell, 2014; Garson, 2013). In this study, the correlation coefficient provided a measure of the variability in grade 1 mathematics achievement that is explained by the independent and control variables. Given this research design, the intent of the study was not to establish causal explanation but rather to explain the extent to which kindergarten readiness predicts subsequent mathematics achievement at the end of grade 1 controlling for student demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status.

Data Collection and Instrumentation Procedures

Approval for this study was determined by the Internal Review Board at the University of Louisville. This was a secondary research study that involved the use of existing student enrollment and educational test data collected by JCPS from 2017-2019. The data for this study were collected from normal educational practices that the parents/guardians consented to as part of their child's regular instructional program and routines. These data were obtained by submitting an open records request through the district's general counsel and Data Management, Planning, & Program Evaluation Department. Two instruments were used to collect the educational test data—BRIGANCE Early Childhood Kindergarten Screen III and Measures of Academic

Progress (MAP) Growth K-2. BRIGANCE provided data about students' kindergarten readiness levels. MAP Growth K-2 provided data about students' mathematics achievement status and growth in grade 1.

BRIGANCE Early Childhood Kindergarten Screen III. Items in BRIGANCE are both criterion-referenced and norm-referenced allowing for comparisons of performance between children on a set of developmentally appropriate skills. For this study, overall composite scores determined by the core assessment in three domains—physical development, language development, and academic skills/cognitive development—were used to measure kindergarten readiness levels. Composite scores in each domain indicate a student's performance on a normative scale with a mean of 100 and a standard deviation of 15. A score less than 90 indicates below average performance. A score between 90 and 110 indicates average performance. A score of 111 or greater indicates above average performance (French, 2013).

Score reliability for BRIGANCE has been established for internal consistency, standard error of measurement, test-retest reliability, and inter-rater reliability. Additionally, an assessment of the validity of BRIGANCE provides evidence of both content validity and construct validity. Further, test validation evidence reflects that BRIGANCE scores are highly correlated with other commonly utilized measures of developmental skills including the Woodcock-Johnson III (WJ-III) and the Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV) (French, 2013).

Measures of Academic Progress (MAP) Growth K-2. The MAP Growth K-2 is an interim assessment published by NWEA. This computerized adaptive assessment is designed for measuring achievement status and growth of students in kindergarten

through grade 2. The MAP Growth K-2 includes an assessment for mathematics aligned to the Common Core State Standards (CCSS). The math assessment includes the following sub-areas: Operations and Algebraic Thinking, Numbers and Operations, Measurement and Data, and Geometry (Northwest Evaluation Association, 2019b).

NWEA developed an equal-interval vertical scale, Rausch unIT (RIT) scale, with a range of scores from 100 to 310. This scale allows for the measurement of achievement status and growth independent of grade level. According to the 2015 NWEA RIT Scale Norms Study, the normative achievement status for grade 1 mathematics is 162.4 ($SD = 12.87$) at the beginning of the school year and 180.8 ($SD = 13.63$) at the end of the school year. The normative fall to spring growth in mathematics is 18.4 ($SD = 7.45$) (Thum & Hauser, 2015).

Neighborhood Socioeconomic Status. Orfield and Frankenberg (2011) and Wicinas (2011) developed a system to classify each of the 540 neighborhoods identified in the 2010 Jefferson County Census as Category 1, 2 or 3. These classifications represent a continuum where Category 1 designates the least advantaged socioeconomic status and Category 3 designates the most advantaged socioeconomic status. Each overall category was determined by a weighted average of three factors—household income, educational attainment, and percent of non-White residents.

Average household income ranged from \$6,300 to \$156,000. Communities with an income average less than \$42,000 are classified as category 1, an income average between \$42,000 to \$62,000 are classified as category 2, and an income average greater than \$62,000 are classified as category 3. Average educational attainment levels ranged from level 1 (finished grade 8 or less) to level 6 (doctorate). Table 2 displays the values

assigned to each educational level. Communities with an education average less than 3.5 are classified as category 1, an education average between 3.5 to 3.7 are classified as category 2, and an education average greater than 3.7 are classified as category 3.

Table 2

Educational Attainment

Weight	Education Level
1	Finished grade 8 or less
2	Did not finish High School
3	Finished High School
3.5	Some college or associate degree
4	Bachelor's degree
5	Masters or professional degree
6	Doctorate

Source: Wicinas, 2011

The racial composition of neighborhoods ranged from 0 to 100 percent White. Communities with less than 73 percent White residents are classified as category 1, category 2 includes communities with 73 to 88 percent White residents, and category 3 includes communities with more than 88 percent White residents. Table 3 displays the three category classifications of 1, 2, or 3 for each factor. The values for each factor were combined to determine an overall classification using the following weighted formula: Socio-economic Combination Category = 1 + .23 (Income Category) + .33 (Education Category) + .33 (Percent White category).

Table 3

Neighborhood Socioeconomic Classifications for Jefferson County

Factor	Category 1	Category 2	Category 3
Household Income	< \$42,000	\$42,000 - \$62,000	> \$62,000
Educational Attainment	< 3.5	3.5 – 3.7	> 3.7
Race (% White)	< 73	73 – 88	> 88

Source: Wicinas, 2011

A weighted average less than 2 was assigned an overall classification of Category 1. A weighted average less than 3 was assigned an overall classification of Category 2. A weighted average of 3 or greater was assigned an overall classification of Category 3. The application of this system resulted in 30%, 46% and 24% of neighborhoods classified as Category 1, Category 2, and Category 3 respectively (Orthfield & Frankenberg, 2011; Wicinas, 2011).

Participants

The target population for this study was grade 1 students enrolled in JCPS during the 2018-2019 school year. In total, there were 5,450 grade 1 students who were administered BRIGANCE at kindergarten entry and MAP Growth K-2 in the fall and spring of grade 1. From this group of potential participants, 650 were excluded based on parent/guardian report of prior setting the year before kindergarten entry as two or more settings, other, or unknown and/or race identified as other. Table 4 summarizes the demographic characteristics of the remaining 4,800 participants. BRIGANCE results indicate that 55.6% the participants were identified as kindergarten ready and 44.4% were identified as not ready. Enrollment data for the participants reflected a racial composition of White (42.3%), African American (34.4%), Latinx (11.6%), Asian (5.0%) and two or more races (6.7%) with 50.6% of students identified as male, 49.5% identified as female, and 11.1% identified as English language learners. In the year prior to kindergarten entry, 32.1% of participants attended a private child care center, 30% attended a state-funded preschool, and 8.8% attended Head Start compared to 29.2% whose early care and learning occurred in the home setting. Among the participants, 31% reside in the least advantaged socioeconomic areas and 19.1% reside in the most advantaged

socioeconomic areas while 49.8% live in areas designated as the middle of this continuum.

Table 4

Demographic Characteristics of Study Participants

	N	%
All	4800	
BRIGANCE		
Kindergarten Ready	2669	55.6
Kindergarten Not Ready	2131	44.4
Race		
White	2030	42.3
African American	1653	34.4
Latinx	556	11.6
Two or more races	323	6.7
Asian	238	5.0
Gender		
Male	2428	50.6
Female	2372	49.4
Language		
English Proficient	4267	88.9
English Language Learner	533	11.1
Prior Setting		
Private Child Care Center	1542	32.1
State-funded Preschool	1438	30.0
Home	1400	29.2
Head Start	420	8.8
Neighborhood SES		
Category 1-Low	1486	31.0
Category 2-Middle	2392	49.8
Category 3-High	922	19.2

Data Analysis Procedures

In this study, hierarchical linear multiple regression analysis was used to examine the predictive relationship between the independent variable of kindergarten readiness and the dependent variable of grade 1 mathematics achievement, controlling for student demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status. Specifically, hierarchical multiple regression, also known as block

regression or nested regression, was used to determine the order that each of the predictor variables were entered into the analysis. This method utilizes theory-based decisions to test the study hypotheses rather than simultaneous regression or the use of beta weights to determine how variables are included in the analysis (Garson, 2014; Petrocelli, 2003). The hierarchical regression method also allows the researcher to add variables to the analysis in blocks. A comparison of the *F*-ratio of each sequential block is useful for understanding which set of predictor variables improve the model (Field, 2013). Petrocelli (2003) contends that other methods of regression analysis (i.e., stepwise, forward, backward) are often criticized because the results are specific to the sample and therefore do not result in consistent and accurate predictions within the population.

Given that preliminary descriptive statistics indicate differences in kindergarten readiness between student groups based on race/ethnicity, gender, and language, these demographic variables comprised Block 1. Block 2 included prior setting for early care and learning and neighborhood socioeconomic status. These variables are contextual factors that may influence the relationship between kindergarten readiness and subsequent grade 1 end-of-year mathematics achievement. Lastly, Block 3 included kindergarten readiness. The contribution of each variable block was determined by changes in *R*-squared in each successive block with a statistical significance level of $\alpha = 0.05$ used for hypothesis testing. This process was used to determine if kindergarten readiness was a significant predictor of grade 1 end-of-year mathematics achievement after controlling for student-level demographic characteristics and contextual factors.

Multiple regression analysis requires that the following assumptions and conditions are met to reduce errors in the regression model: linearity assumption,

independence assumption, equal variance assumption, and normality assumption (Bock, Velleman, & De Veaux, 2015). To test the linearity assumption, scatterplots of grade 1 mathematics scores against kindergarten readiness scores will need to show a general linear pattern with no bends or other nonlinearities. This same assumption must be met for each of the predictor variables. To test the independence assumption, the Durbin-Watson test will be used to detect correlations between the residual errors. The results of this test statistic range from 0 to 4, with a value close to 2 indicating that the residual terms are uncorrelated. In general, values less than 1 indicate a strong positive correlation and values greater than 3 indicate a strong negative correlation. To meet the equal variance assumption, a scatterplot of kindergarten readiness scores against the residual terms should show a general pattern of constant variance across each level of the predictor variables. To indicate equal variance (or homoscedasticity) a visual check of the scatterplot would show a nearly uniform spread around the regression line, whereas unequal variance (or heteroscedasticity) will tend to show a fan or cone shape around the regression line. Lastly, to test the normality assumption, a histogram of the residual errors should appear to be normally distributed with a mean of zero or very close to zero (Bock et al., 2015; Fields, 2013).

A statistical package, SPSS Statistics, was used to perform the statistical tests to detect violations of these assumptions as well as to perform the statistical procedures to test the null hypothesis. The results were reported as a *F*-ratio along with the degrees of freedom and the significance levels. The *R*-squared value was interpreted to explain the variance in grade 1 mathematics achievement that is accounted for by kindergarten readiness. The coefficients for each of the control variables was interpreted to understand

the direction and magnitude of the association with grade 1 mathematics achievement.

The multiple regression model was represented in the following format: $y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \varepsilon$ where β represents the coefficients for the predictors and ε represents the errors (Bock et al., 2015).

CHAPTER 4: RESULTS

Descriptive and inferential statistics were used to address the following research question:

RQ1: Does kindergarten readiness predict grade 1 end-of-year mathematics achievement, controlling for students' demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status?

The following were my hypotheses regarding the research question:

H₁₀: There is no relationship between kindergarten readiness and grade 1 end-of-year mathematics achievement.

H₁₁: There is a positive relationship between kindergarten readiness and grade 1 end-of-year mathematics achievement.

Descriptive analysis was performed to understand characteristics of the study sample, specifically grade 1 mathematics achievement status and growth across student groups. Hierarchical linear multiple regression analyses were conducted to understand the extent to which kindergarten readiness and the control variables predict and explain variation in subsequent mathematics achievement at the end of grade 1. Taken together, the results of these analyses extend our understanding of the relationship between achievement gaps, opportunity gaps, and mathematics outcomes in early elementary school.

Descriptive Analysis

The descriptive analysis provides additional background for understanding characteristics of the study sample and contextual information on the differences in

mathematics achievement status and growth across student groups. The dependent variable, grade 1 end-of-year mathematics achievement, was measured using RIT scores from the MAP Growth K-2 mathematics assessment. According to the 2015 NWEA RIT Scale Norms Study, the normative achievement status for grade 1 mathematics is 162.4 ($SD = 12.87$) at the beginning of the year and 180.8 ($SD = 13.63$) at the end of the year (Thum & Hauser, 2015). Table 5 reports the means and standard deviations of scores from the MAP Growth K-2 mathematics assessments administered to study participants at the beginning of grade 1 (fall 2018) and the end of grade 1 (spring 2019). The mean score for all students was 160.19 ($SD = 15.39$) at the beginning of the school year and 178.74 ($SD = 16.30$) at the end of the school year. At the beginning of grade 1, the mean score for students categorized as not ready at kindergarten entry ($M = 152.03$, $SD = 14.03$) was below the achievement status norm ($M = 162.4$, $SD = 12.87$) and lower compared to students categorized as ready ($M = 166.71$, $SD = 13.39$). At the end of grade 1, the mean score for students categorized as not ready at kindergarten entry ($M = 170.21$, $SD = 14.84$) was likewise below the achievement status norm ($M = 180.8$, $SD = 13.63$) and lower compared to students categorized as ready ($M = 185.55$, $SD = 14.06$).

At the beginning of the school year, Asian students ($M = 166.78$, $SD = 15.23$), White students ($M = 164.52$, $SD = 15.22$), and students of two or more races ($M = 162.47$, $SD = 14.13$) had mean scores that were higher than or aligned with the achievement status norm ($M = 162.4$, $SD = 12.87$). In comparison, the mean scores for Latinx students ($M = 156.33$, $SD = 14.47$) and African American students ($M = 154.78$, $SD = 14.01$) were lower than the achievement status norm ($M = 162.4$, $SD = 12.87$). The mean scores for Asian students ($M = 188.17$, $SD = 15.92$) and White students ($M = 183.50$, $SD = 15.77$) were

also higher than the achievement status norm ($M = 180.8$, $SD = 13.63$) at the end of the year. However, the mean score for students of two or more races ($M = 180.13$, $SD = 15.62$) was approximately 0.7 below normative achievement status. The mean score for Latinx students ($M = 175.03$, $SD = 14.59$) and African American students ($M = 172.53$, $SD = 15.05$) at the end of the year continued to be lower than the achievement status norm ($M = 180.13$, $SD = 15.62$).

The mean score for female students ($M = 160.54$, $SD = 14.13$) was 0.69 higher than the mean score for male students ($M = 159.85$, $SD = 16.52$) at the beginning of the school year. However, the mean score for female students ($M = 178.59$, $SD = 14.73$) was 0.30 lower than male students ($M = 178.89$, $SD = 17.70$) at the end of the year. The mean scores for female students and male students were below the achievement status norm at the beginning of the year and the end of the year. Likewise, the mean scores of English proficient students ($M = 160.95$, $SD = 15.25$) and English language learners ($M = 154.13$, $SD = 15.15$) are below the achievement status norm at the beginning of the school year. At the end of the year, the mean scores of English proficient students ($M = 179.34$, $SD = 16.30$) and English language learners ($M = 173.93$, $SD = 15.53$) were also below the achievement status norm.

At the beginning of grade 1, the mean score for students who attended a private child care center prior to kindergarten entry ($M = 166.91$, $SD = 14.41$) was higher than the achievement status norm ($M = 162.4$, $SD = 12.87$). In comparison, the mean scores for students whose early learning and care was provided in a state-funded preschool ($M = 157.42$, $SD = 14.62$), in the home setting ($M = 156.89$, $SD = 15.28$), or in a Head Start program ($M = 156.02$, $SD = 13.75$) were lower than the achievement status norm ($M =$

162.4, $SD = 12.87$). At the end of the year, the mean scores for students who attended a private child care center prior to kindergarten entry ($M = 186.24$, $SD = 15.23$) remained higher than the achievement status norm ($M = 180.8$, $SD = 13.63$). The mean scores for students whose early learning and care was provided in a state-funded preschool ($M = 175.31$, $SD = 15.98$), in the home setting ($M = 175.79$, $SD = 15.38$), and in a Head Start program ($M = 172.80$, $SD = 14.58$) continued to be lower than the achievement status norm ($M = 180.13$, $SD = 15.62$) at the end of the year.

The mean scores for students in neighborhoods with lower average socioeconomic status, Category 1 ($M = 154.51$, $SD = 14.63$) and Category 2 ($M = 160.58$, $SD = 14.53$), were below the achievement status norm ($M = 162.4$, $SD = 12.87$) at the beginning of grade 1 and lower compared to students in neighborhoods with higher average socioeconomic status, Category 3 ($M = 168.33$, $SD = 14.89$). At the end of grade 1, the mean scores for students in Category 1 neighborhoods ($M = 172.34$, $SD = 15.73$) and Category 2 neighborhoods ($M = 179.42$, $SD = 15.15$) were likewise below the achievement status norm ($M = 180.8$, $SD = 13.63$) and lower compared to students in Category 3 neighborhoods ($M = 187.31$, $SD = 15.76$).

A Pearson correlation coefficient was calculated for the relationship between fall scores and spring scores. Generally, correlation coefficients close to 0 represent a weak relationship while coefficients close to the absolute value of 1 represent a strong relationship (Cronk, 2016). A high positive correlation was found ($r = 0.83$, $p < .001$), indicating a significant linear relationship between fall scores and spring scores.

Table 5

Mean RIT Score on MAP Growth K-2 Assessment for Each Student Group

	Beginning of Year (Fall 2018)		End of Year (Spring 2019)	
	Mean	<i>SD</i>	Mean	<i>SD</i>
All	160.19	15.39	178.74	16.30
BRIGANCE				
Kindergarten Ready	166.71	13.39	185.55	14.06
Kindergarten Not Ready	152.03	14.03	170.21	14.84
Race				
White	164.52	15.22	183.50	15.77
African American	154.78	14.01	172.53	15.05
Latinx	156.33	14.47	175.03	14.59
Two or more races	162.47	14.13	180.13	15.62
Asian	166.78	15.23	188.17	15.92
Gender				
Male	159.85	16.52	178.89	17.70
Female	160.54	14.13	178.59	14.73
Language				
English Proficient	160.95	15.25	179.34	16.30
English Language Learner	154.13	15.15	173.93	15.53
Prior Setting				
Private Child Care Center	166.91	14.41	186.24	15.23
State-funded Preschool	157.42	14.62	175.31	15.98
Home	156.89	15.28	175.79	15.38
Head Start	156.02	13.75	172.80	14.58
Neighborhood SES				
Category 1-Low	154.51	14.63	172.34	15.73
Category 2-Middle	160.58	14.53	179.42	15.15
Category 3-High	168.33	14.89	187.31	15.76

According to the 2015 NWEA RIT Scale Norms Study, the normative fall to spring growth for grade 1 mathematics on the MAP Growth K-2 Assessment is 18.4 ($SD = 7.45$) (Thum & Hauser, 2015). Table 6 reports the means and standard deviations of growth scores across student groups for this study. The mean growth score for all students was 18.55 ($SD = 9.18$), students categorized as ready was 18.85 ($SD = 8.61$), and students categorized as not ready was 18.18 ($SD = 9.84$). Asian students ($M = 21.39$, $SD = 9.65$) and White students ($M = 18.98$, $SD = 8.85$) were above the norm and demonstrated

more growth compared to Latinx students ($M = 18.69, SD = 9.24$), African American students ($M = 17.75, SD = 9.23$), and students of two or more races ($M = 17.66, SD = 9.88$). Likewise, male students ($M = 19.04, SD = 9.72$) were above the norm and showed more growth than female students ($M = 18.05, SD = 18.05$). English language learners ($M = 19.80, SD = 9.11$) were above the growth norm and students who are proficient in English ($M = 18.40, SD = 9.18$) were aligned with the growth norm. Students who attended a private child care center ($M = 19.33, SD = 8.69$) and students whose early care and learning was provided in the home setting ($M = 18.90, SD = 9.31$) were above the norm for growth and showed more growth than students who attended a state-funded preschool ($M = 17.89, SD = 9.64$) or a Head Start Program ($M = 16.78, SD = 8.69$). Students in neighborhoods with more socioeconomic advantage (Category 3: $M = 18.98, SD = 9.07$; Category 2: $M = 18.84, SD = 9.03$) showed more growth compared to students in neighborhoods with the least socioeconomic advantage ($M = 17.83, SD = 9.45$).

Table 6

Mean Growth on MAP Growth K-2 Assessment for Each Student Group

	Fall to Spring Growth	
	Mean	<i>SD</i>
All	18.55	9.18
BRIGANCE		
Kindergarten Ready	18.85	8.61
Kindergarten Not Ready	18.18	9.84
Race		
White	18.98	8.85
African American	17.75	9.23
Latinx	18.69	9.24
Two or more races	17.66	9.88
Asian	21.39	9.65
Gender		
Male	19.04	9.72
Female	18.05	8.56
Language		
English Proficient	18.40	9.18
English Language Learner	19.80	9.11
Prior Setting		
Private Child Care Center	19.33	8.63
State-funded Preschool	17.89	9.64
Home	18.90	9.31
Head Start	16.78	8.69
Neighborhood SES		
Category 1	17.83	9.45
Category 2	18.84	9.03
Category 3	18.98	9.07

Hierarchical Multiple Regression Analysis

The first step of conducting the hierarchical multiple regression analysis was to determine whether the relevant assumptions and conditions were met. Residual statistics detected outliers (i.e., standardized residual values greater than ± 3 standard deviations) that could reduce the predictive accuracy of the regression model. A casewise diagnostic table was used to identify and exclude these cases ($n = 41$) from the study. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.841. The d

statistic was between the two critical values of $1.5 < d < 2.5$ and close to 2 indicating no concern with correlations between the residual errors. There was homoscedasticity, as assessed by a visual inspection of the scatterplot of standardized residuals against predicted values. In the scatterplot, the spread of residuals was approximately constant across the predicted values, which is consistent with the assumption of homoscedasticity. There was no violation of the assumption of normality detected, as assessed by a visual inspection of the histogram that showed the standardized residuals appear to be approximately normally distributed. This was confirmed by a visual inspection of the normal P-P plot of standardized residuals that showed the points are relatively aligned to a diagonal line. The variance inflation factor (VIF) was calculated for all predictor variables included for multiple regression analysis to detect multicollinear variables. VIF values were < 10 for all variables, indicating no concern with multicollinearity (Ho, 2013; Laerd Statistics, 2015).

Kindergarten Readiness and Grade 1 Mathematics Achievement Status

A hierarchical multiple regression was conducted with grade 1 end-of-year mathematics scores from the MAP Growth K-2 assessment as the dependent variable. Independent variables were entered sequentially as blocks in the hierarchical regression and the results are summarized in Table 7. In Block 1, student demographic characteristics were entered into the model. In general, race, gender, and language accounted for 12.5% of the variation in grade 1 end-of-year mathematics achievement, and this model was statistically significant $F(6, 4752) = 113.08, p < .001$. In Block 2, variables associated with opportunity gap were entered into the model. An additional 6.7% of variance was explained after adding prior setting for early care and learning and

neighborhood socioeconomic status. This model was also statistically significant $F(11, 4747) = 102.50, p < .001$ and accounted for 19.2% of the variation in grade 1 end-of-year mathematics achievement. In Block 3, kindergarten readiness was introduced into the model, which increased the explained variance by 16.5%. The final model was statistically significant $F(12, 4746) = 219.68, p < .001$, and accounted for 35.7% of the variation in grade 1 end-of-year mathematics achievement.

As reported in Table 7, the coefficients in Block 3 indicated that the contributions of multiple variables to the regression model were statistically significant. In terms of race, White students were used as the referent group. In comparison to the referent group, the unstandardized regression coefficient for Asian students was 3.40 indicating that Asian students had a RIT score 3.40 units higher than White students. In contrast, the coefficient for African American students was -6.25 indicating that African Americans had a RIT score 6.25 units lower than White students. Likewise, the coefficient for Latinx students was -1.77 indicating that Latinx students had a RIT score 1.77 units lower than White students. These findings were all statistically significant indicating an achievement gap by race between study participants in grade 1 end-of-year mathematics. Although, the coefficient of -1.17 for students of two or more races indicated that students of two or more races had a RIT score 1.17 units lower than White students, this difference was not statistically significant.

In comparison to male students, an unstandardized regression coefficient of -1.85 for female students indicated that female students had a RIT score 1.85 units lower than male students. In models 1 and 2, gender was not a significant predictor; however, in model 3 gender was a significant predictor. In comparison to English proficient students,

the unstandardized regression coefficient was -1.22 indicating that English language learners had a RIT score 1.22 units lower than English proficient students. In models 1 and 2, language was a significant predictor; however, language was not significant predictor in model 3.

In terms of prior setting for early care and learning, students who attended a private child care center prior to kindergarten entry were the referent group. In comparison to the referent group, the unstandardized regression coefficient for students whose early learning and care was provided in their home setting was -1.42 indicating that students in the home setting had a RIT score 1.42 units lower than students who attended a private child care center. Comparatively, the coefficient for students who attended a state-funded preschool was -5.55 and the coefficient for students who attended a Head Start program was -6.62. This indicates that students whose early learning and care was provided in a state-funded preschool program had a RIT score 5.55 units lower than students who attended a private child care center. Likewise, students who attended a Head Start program had a RIT score 6.62 units lower than students who attended a private child care center. These results indicate that grade 1 end-of-year mathematics scores differed significantly between prior settings and students who attended a private child care center had higher average scores than students in all other settings.

In terms of neighborhood socioeconomic status, Category 2 was the referent group. In comparison to the referent group, the unstandardized regression coefficient for Category 1 was -2.83 and for Category 3 was 2.07. These results indicate that students from Category 3 neighborhoods had RIT scores 2.07 units higher than students in Category 2 neighborhoods. However, students in Category 2 neighborhoods had RIT

scores 2.83 higher than students in Category 2 neighborhoods. These results indicate that grade 1 end-of-year mathematics scores differed significantly between students by neighborhood socioeconomic status and higher average scores were found as socioeconomic advantaged increased.

The largest contribution to the regression model was represented by the kindergarten readiness variable. In comparison to students categorized as kindergarten ready, the unstandardized regression coefficient for students categorized as not ready was -14.06. After accounting for other study variables, these results indicate that students categorized as ready had a RIT score 14.06 units higher on the grade 1 end-of-year MAP Growth K-2 mathematics assessment compared to students categorized as not ready.

Table 7

HLMR Results—Kindergarten Readiness and Grade 1 Mathematics Achievement Status

Variable	R^2	ΔR^2	F	Unstandardized	
				B	$SE B$
<i>Block 1</i>	.125	.125	113.08*		
(Constant)				184.29*	0.39
African American				-10.80*	0.49
Asian				5.67*	1.04
Latinx				-5.80*	0.80
Two or more				-3.29*	0.88
Female				-0.72	0.42
ELL				-5.23*	0.79
<i>Block 2</i>	.192	.067	102.50*		
(Constant)				186.69*	0.53
African American				-6.21*	0.55
Asian				5.90*	1.00
Latinx				-3.27*	0.79
Two or more				-1.08	0.86
Female				-0.79	0.41
ELL				-2.99*	0.78
Head Start				-7.35*	0.84
Home				-6.66*	0.57
Preschool				-6.15*	0.57
Category 1				-3.09*	0.52
Category 3				3.82*	0.59
<i>Block 3</i>	.357	.165	219.68*		
(Constant)				191.68*	0.49
African American				-6.25*	0.49
Asian				3.40*	0.90
Latinx				-1.77*	0.71
Two or more				-1.17	0.76
Female				-1.85*	0.37
ELL				-1.22	0.70
Head Start				-6.62*	0.75
Home				-1.42*	0.53
Preschool				-5.55*	0.51
Category 1				-2.83*	0.46
Category 3				2.07*	0.52
BRIGANCE				-14.06*	0.40

Notes: * represents $p < .05$

Kindergarten Readiness, Prior Level of Achievement, and Grade 1 Mathematics Achievement Status

This analysis sought to identify the predictive relationship between kindergarten readiness and mathematics achievement; specifically, if it is improved by the inclusion of students' prior level of achievement (i.e., Fall MAP RIT score). In Block 1, student demographic characteristics were entered into the model including prior level of achievement as indicated by scores on the MAP Growth K-2 mathematics assessment at the beginning of grade 1. In general, race, gender, language, and prior level of achievement accounted for 73.8% of the variation in grade 1 end-of-year mathematics achievement, and this model was statistically significant $F(7, 4746) = 1906.06, p < .001$. In Block 2, variables associated with opportunity gap were entered into the model. An additional 0.4% of variance was explained after adding prior setting for early care and learning and neighborhood socioeconomic status. This model was also statistically significant $F(12, 4741) = 1131.59, p < .001$ and accounted for 74.1% of the variation in grade 1 end-of-year mathematics achievement. In Block 3, kindergarten readiness was introduced into the model, which increased the explained variance by 0.8%. The overall model was statistically significant $F(13, 4740) = 1087.82, p < .001$ and accounted for 74.9% of the variation in grade 1 end-of-year mathematics achievement.

As reported in Table 8, the coefficients in Block 3 indicated that the contributions of multiple variables to the regression model were statistically significant. In terms of race, White students were used as the referent group. In comparison to the referent group, the unstandardized regression coefficient for Asian students was 2.34 indicating that Asian students had a RIT score 2.34 units higher than White students. In contrast, the

coefficient for African American students was -1.92 indicating that African Americans had a RIT score 1.92 units lower than White students. Likewise, the coefficient for Latinx students was -1.01 indicating that Latinx students had a RIT score 1.01 units lower than White students. The coefficient for students of two or more races was -1.14 indicating that students of two or more races had a RIT score 1.14 units lower than White students. These findings were all statistically significant indicating an achievement gap by race between study participants in grade 1 end-of-year mathematics.

In comparison to male students, an unstandardized regression coefficient of -1.37 for female students indicated that female students had a RIT score 1.37 units lower than male students. Gender was a significant predictor across models. In comparison to English proficient students, the unstandardized regression coefficient was 0.98 indicating that English language learners had a RIT score 0.98 units higher than English proficient students. In models 1 and 2, language was not a significant predictor; however, language was a significant predictor in model 3.

In terms of prior setting for early care and learning, students who attended a private child care center prior to kindergarten entry were the referent group. In comparison to the referent group, the unstandardized regression coefficient for students whose early learning and care was provided in their home setting was -0.36, indicating that students in the home setting had a RIT score 0.36 units lower than students who attended a private child care center. Although the coefficient for students whose early learning and care was provided in the home setting indicated lower average scores compared to students who attended a private child care center, this difference was not statistically significant. Comparatively, the coefficient for students who attended a state-

funded preschool was -1.96 and the coefficient for students who attended a Head Start program was -2.83. This indicates that students whose early learning and care was provided in a state-funded preschool program had a RIT score 1.96 units lower than students who attended a private child care center. Likewise, students who attended a Head Start program had a RIT score 2.83 units lower than students who attended a private child care center. These results indicate that grade 1 end-of-year mathematics scores differed significantly between prior settings and students who attended a private child care center had higher average scores than students who attended a state-funded preschool or a Head Start program.

In terms of neighborhood socioeconomic status, Category 2 was the referent group. In comparison to the referent group, the unstandardized coefficient for Category 1 was -0.86 indicating that Category 1 students had RIT scores 0.86 lower than Category 2 students. This difference between Category 1 students and Category 2 students was significantly different. In contrast, the coefficient for Category 3 was 0.05 indicating that Category 3 students had a RIT score 0.05 higher than Category 2 students. However, this difference was not significantly different.

The largest contribution to the regression model was again represented by the kindergarten readiness variable. In comparison to students categorized as kindergarten ready, the unstandardized regression coefficient for students categorized as not ready was -3.48. After accounting for prior level of achievement and other study variables, students categorized as ready had an average RIT score 3.48 units higher than students categorized as not ready compared to 14.06 units higher in the prior analysis. In both analyses, grade 1 end-of-year mathematics achievement differed significantly between students who met

the readiness benchmark and students who entered kindergarten below the readiness benchmark.

Table 8

HLMR Results—Kindergarten Readiness, Prior Levels of Achievement and Grade 1 Mathematics Achievement Status

Variable	R^2	ΔR^2	F	Unstandardized	
				B	$SE B$
<i>Block 1</i>	.738	.738	1906.06*		
(Constant)				40.25*	1.39
Fall MAP score				0.87*	0.01
African American				-2.66*	0.29
Asian				2.57*	0.58
Latinx				-1.91*	0.45
Two or more				-1.55*	0.50
Female				-1.11*	0.24
ELL				0.58	0.45
<i>Block 2</i>	.741	.004	1131.59*		
(Constant)				43.57*	1.46
Fall MAP score				0.86*	0.01
African American				-1.64*	0.32
Asian				2.77*	0.58
Latinx				-1.27*	0.46
Two or more				-1.10*	0.50
Female				-1.13*	0.24
ELL				0.78	0.45
Head Start				-2.74*	0.49
Home				-1.33*	0.33
Preschool				-1.84*	0.33
Category 1				-0.80*	0.30
Category 3				0.27	0.34
<i>Block 3</i>	.749	.008	1087.82*		
(Constant)				53.14*	1.64
Fall MAP score				0.81*	0.01
African American				-1.92*	0.32
Asian				2.34*	0.57
Latinx				-1.01*	0.45
Two or more				-1.14*	0.49
Female				-1.37*	0.23
ELL				0.98*	0.45
Head Start				-2.83*	0.48
Home				-0.36	0.34
Preschool				-1.96*	0.33
Category 1				-0.86*	0.30
Category 3				0.05	0.34
BRIGANCE				-3.48*	0.29

Notes: * represents $p < .05$

The results of this analysis revealed that the inclusion of students' prior level of achievement resulted in smaller differences in grade 1 end-of-year mathematics achievement between student groups. However, even after accounting for prior level of achievement, students who met the kindergarten readiness benchmark had higher average grade 1 end-of-year mathematics achievement compared to students who did not meet the kindergarten readiness benchmark at school entry. Taken together, the hierarchical multiple regression analyses indicate a statistically significant predictive relationship exists between kindergarten readiness and grade 1 end-of-year mathematics, after controlling for students' demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status. Given these results, the null hypothesis is rejected, and the alternative hypothesis is accepted. The study findings and implications of these results are discussed in Chapter 5.

CHAPTER 5: DISCUSSION

The primary aim of this study was to address the following research question: Does kindergarten readiness predict grade 1 end-of-year mathematics achievement, controlling for students' demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status? The results of this study highlight the importance of kindergarten readiness and extend the findings of previous studies that indicate cognitive and non-cognitive measures of readiness are associated with later academic, social, and health outcomes (Davies, Janus, Duku, & Gaskin, 2016; Hair, Halle, Terry-Humen, Lavelle, & Calkins, 2006; Pace, Alper, Burchinal, Golinkoff, & Hirsh-Pasek, 2019; Sabol & Pianta, 2012). In this study, kindergarten readiness—determined by academic skills/cognitive development, language development, and physical development—was a significant predictor of grade 1 end-of-year mathematics achievement. The model predictions show that kindergarten students who met the readiness benchmark had higher grade 1 end-of-year mathematics scores compared to students who entered kindergarten below the readiness benchmark. The model predictions improved substantially with the inclusion of prior level of achievement as indicated by grade 1 beginning of the year mathematics achievement. However, students with stronger readiness skills demonstrated significantly higher grade 1 mathematics scores compared to students with lower readiness skills, irrespective of whether prior level of achievement was controlled. These findings suggest that the achievement of students before and during the kindergarten year are significant predictors of subsequent

grade 1 mathematics achievement even after controlling for students' demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status. In the following sections, these study findings are further discussed along with implications for policy and future research.

Findings

Educational research on students' academic performance has consistently demonstrated disparities in outcomes between students from different racial and ethnic groups and social class backgrounds (Carnoy & Garcia, 2017; Reardon, Robinson-Cimpian, & Weathers, 2014). The findings of this study are generally consistent with previous research that show a persistent gap in student achievement data that are correlated with students' demographic characteristics and other contextual factors (Lee, 2002; Pitre, 2014; Sousa & Armor, 2016). Collectively, the results from this study show that general knowledge and skill gaps at kindergarten entry between African American students and White students and Latinx students and White students are predictive of differences in grade 1 end-of-year mathematics achievement. Notably, these findings at the end of grade 1 align with national and state assessment data for grades 3-12 which show similar patterns of achievement gaps in mathematics between students from different racial and ethnic backgrounds (Kentucky Department of Education, 2019b; National Center for Education Statistics, 2020). These findings suggest that race-based achievement gaps in mathematics may emerge early and contribute to gaps that persist over time.

Consistent with previous research on mathematics achievement in early elementary grades (Reardon, Fahle, Kalogrides, Podolsky, & Zarate, 2019; Lindberg,

Hyde, Peterson, & Linn, 2010; Hyde, Lindberg, Linn, Ellis & Williams, 2008; Robinson & Lubienski, 2011), the findings from this study indicate no clear gender-related difference in grade 1 end-of-year mathematics achievement. However, prior research has revealed that gender becomes more influential in different contexts. For example, researchers have found that gender differences in mathematics vary across the achievement continuum, across grade levels, and across socioeconomic contexts (Cimpian, Lubienski, Timmer, Makowski, & Miller, 2016; Figlio, Karbownik, Roth, & Wasserman, 2019; Sohn, 2012). Additionally, prior research suggests that a gender stereotype (i.e., generalization that male students are better at math than female students) is learned in early elementary grades and influences the development of a gap in mathematics achievement status and growth that reinforces the gender stereotype (Cvencek, Meltzoff, & Greenwald, 2011).

A somewhat unexpected finding in this study was that the average mathematics achievement score for English language learners was higher than the score for English proficient students, after accounting for kindergarten readiness and prior level of achievement. This finding does not align with previous research that shows English language learners tend to score lower in mathematics compared to English proficient students (Carnoy & Garcia, 2017; Hemphill & Vanneman, 2011). However, in a quasi-experimental study Saxe and Sussman (2019) showed that the achievement gap in mathematics between English language learners and English proficient students narrowed and in some settings was eliminated with the implementation of a curriculum (e.g., Learning Mathematics Through Representations) designed to support a language inclusive classroom. Notably, there was no difference in their finding when the ethnicity

and gender of the English language learner was considered. A limitation of my study is that the use of an existing dataset with de-identified information does not allow for further exploration of learning contexts and other factors that may have influenced this particular finding.

According to prior studies, differences in students' cognitive and non-cognitive development at kindergarten entry are largely explained by differences in students' early care and learning experiences (Magnuson, Meyers, Ruhm, & Waldfogel, 2004; Yoshikawa, Weiland, & Brooks-Gunn, 2016). The descriptive data in the present study show that students who attend a private child care center are more likely to demonstrate higher levels of kindergarten readiness compared to students whose early learning and care is provided in their home setting, in a state-funded preschool, or in a Head Start program. Additionally, previous research provides evidence of longer-term associations between early childhood educational experiences, kindergarten readiness, and subsequent academic achievement (Ansari, 2018; Lehl, Kluczniok, & Rossbach, 2016). The findings of this study further indicate that private child care centers show positive short- and longer-term impacts on students' outcomes, specifically grade 1 mathematics achievement status and growth. These findings suggest the need to address the readiness outcome gap that exists between early childhood education programs and is predictive of differences in students' grade 1 mathematics performance.

With respect to neighborhood socioeconomic status, grade 1 mathematics achievement scores differed significantly across the continuum where Category 3 represents the most advantaged socioeconomic status and Category 1 represents the least advantaged socioeconomic status. In this study, neighborhood socioeconomic status was

measured by the average household income, average level of educational attainment, and racial composition of a census block. The results suggest that grade 1 mathematics achievement increases as neighborhood socioeconomic status increases. More specifically, grade 1 end-of-year mathematics achievement scores for students residing in Category 3 neighborhoods were significantly higher than scores for students residing in Category 2 neighborhoods. Comparatively, scores for students residing in Category 2 neighborhoods were significantly higher than scores for students residing in Category 1 neighborhoods. These findings are consistent with recent research that found achievement gaps between students from disadvantaged neighborhoods and more advantaged neighborhoods, including negative implications for students' developmental and academic outcomes prior to kindergarten entry into early elementary grades for students from economically disadvantaged neighborhoods (Chetty, Hendren, & Katz, 2016; Morrissey & Vinopal, 2018a; Vinopal & Morrissey, 2020). Recent research also indicates that educational opportunity and outcomes vary between neighborhoods, including access to early childhood education programs that promote kindergarten readiness (Reardon, 2019). Although social class does not determine achievement, Rothstein (2013) points out that contextual and experiential factors associated with social and economic class (e.g., healthcare, housing, school and neighborhood conditions, informal learning opportunities) have implications for students' learning experiences and educational outcomes.

To further evaluate the predictive validity of kindergarten readiness, prior level of achievement (i.e., Fall MAP RIT scores) was included in the prediction model. With few exceptions, a comparison of prediction models showed similar patterns in terms of which

study variables were significant predictors of grade 1 end-of-year mathematics achievement scores. In both models, kindergarten readiness emerged as a significant predictor and students who met the readiness benchmark had significantly higher average mathematics scores compared to students who entered kindergarten below the readiness benchmark. Consistent with previous research, the findings of this study provide additional support for the predictive relationship between kindergarten readiness and subsequent academic achievement. These findings also build upon previous studies of the predictive relationship between early mathematics knowledge and skills and elementary mathematics outcomes (Bodovski & Farkas, 2007; Manfra, Dinehart, & Sembianti, 2014) to examine the predictive relationship between a more comprehensive measure of early knowledge and skills and subsequent mathematics achievement.

In summary, the results of this study indicate that kindergarten readiness is a significant predictor of grade 1 end-of-year mathematics achievement. More specifically, students who met the readiness benchmark at kindergarten entry and students who did not meet the readiness benchmark at kindergarten entry differed significantly in terms of their grade 1 end-of-year mathematics achievement scores. As previously stated, the prediction model explains approximately 36% of grade 1 end-of-year mathematics achievement, while controlling for students' demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status. This is an important finding because the practical significance of the differences in mathematics achievement scores and the percent of variance explained in the prediction model suggests that approximately 36% of grade 1 end-of-year mathematics achievement can be predicted from kindergarten readiness and other known variables at school entry. Furthermore, these findings indicate

that prior level of achievement substantially improves the prediction of mathematics scores at the end of grade 1 and in general decreases differences between student groups. Comparatively, with the inclusion of prior level of achievement approximately 75% of grade 1 end-of-year mathematics achievement can be predicted at the start of the school year. The relationship between kindergarten readiness, prior level of achievement, and grade 1 mathematics achievement suggest that kindergarten readiness assessments and interim assessments may be useful to address low student performance and early achievement gaps systematically. Considering the limited research on the use of interim assessments in early elementary grades and the impact on achievement gaps, this finding is of particular importance. A discussion of implications for policy, practice, and future research follows.

Implications

The findings of this study suggest some important implications for policy, practice, and future research. The predictive relationship between kindergarten readiness and grade 1 end-of-year mathematics achievement found in this study support previous findings that indicate students' future outcomes depend on being prepared at kindergarten entry to participate in and benefit from age-appropriate learning experiences (Ackerman & Barnett, 2005; Duncan et al., 2007; Rabiner, Goodwin, & Dodge, 2016). This reveals the importance of ensuring high-quality early care and learning opportunities as evidenced by kindergarten readiness outcomes. Furthermore, Lamy (2013) contends that for early childhood education programs to change the trajectory of outcomes, particularly for students disadvantaged by social and economic factors, quality matters. Moreover, the achievement gaps between students associated with race, prior setting for early care and

learning, and neighborhood socioeconomic status highlight the need to ensure equitable educational opportunities for children from different social and economic backgrounds. Taken together, the findings of this study and prior research suggests the need to consider implications for early childhood education policies, practices, and research through an equity lens.

Implications for Policy and Practice

In 2015, the Governor’s Office of Early Childhood in Kentucky partnering with the Cabinet for Health and Family Services and Kentucky Department of Education piloted a rating system—now known as Kentucky All STARS—designed to assess and support the quality of early childhood education programs across the state. Domains of Kentucky All STARS (i.e., Classroom and Instructional Quality, Staff Qualifications, Administrative and Leadership Practices, and Family and Community Engagement) were intentionally aligned with federal priority areas identified by the RTT-ELC grant application. STARS level one is obtained by meeting regulatory requirements. In addition to meeting regulatory requirements, STARS level two is obtained by meeting five required standards of quality in domains for Classroom and Instructional Quality (3) and Staff Qualifications (2). STARS levels three, four and five are obtained by accumulating 21-30 points, 31-40 points, and 41-50 points, respectively. STARS levels three through five also specify requirements for environmental observations and minimum point values for each domain. (Commonwealth of Kentucky, 2018). Notably, quality ratings are not linked to kindergarten readiness outcomes. In general, there is evidence to support that participation in state QRIS improves the overall quality of a program (Boller et al., 2015). There remains, however, a need for policy to ensure that

student outcomes are used for the identification of programs where further analysis of the curriculum and instructional practices is needed. Additionally, school- and district-level practices must include a system for analyzing assessment data (e.g., kindergarten readiness assessments, interim assessments, formative assessments) to improve classroom instruction and student learning as well as to inform decisions about the effectiveness of the K-2 program for students who meet the readiness benchmark at kindergarten entry and students who do not meet the readiness benchmark.

Implications for Future Research

The opportunity gap framework emphasizes the need to consider that persistent educational disparities are manifestations of social class differences in educational and social opportunities (Welner & Carter, 2013). Likewise, Ladson-Billings (2006) contends that the term “education debt” more accurately describes the disparities in achievement that have accumulated over time as a result of social and class inequities. The findings of this study indicate that students who have access to private child care centers also have higher levels of readiness at kindergarten entry and higher grade 1 mathematics achievement status and growth compared to peers. The findings of this study also indicate that in general neighborhood socioeconomic status influences student outcomes with lower achievement and growth associated with concentrated neighborhood disadvantage.

In 2007, 90.6% of early care providers in Kentucky accepted subsidy payments through the statewide Child Care Assistance Program (CCAP). From 2007-2017, the percentage of programs accepting subsidy payments decreased to 79% (Rous, Sherif, & Singleton, 2018). This limits affordability and subsequently access to some early childhood programs. This is important because research clearly documents that high-

quality public and private programs are effective in supporting early growth and development particularly for African American students, Latinx students, and students from low-income households and communities (Ansari & Winsler, 2016; Coley, Votruba-Drzal, Collins, & Cook, 2016; Winsler et al., 2008). For this reason, researchers (Johnson-Straub, 2017) contend that to address opportunity gaps and subsequent achievement gaps, the most effective early childhood education programs must be funded sufficiently to expand availability and provide affordable access and resources to underserved communities. This also suggests that rather than focus on comparisons between groups—which some researchers refer to as gap gazing (Gutierrez, 2008; Young, Young, & Caparo, 2018)—there is need for research that examines the learning contexts and environments that support achievement and growth within marginalized student groups. Future studies that focus on kindergarten readiness and mathematics achievement and growth within these groups will further our understanding of how to identify and address opportunity gaps that have implications for students’ educational outcomes.

Conclusions

The findings of this study demonstrate that kindergarten readiness predicts subsequent mathematics achievement status and growth. Furthermore, the results of prediction models that control for student demographic characteristics, prior setting for early care and learning, and neighborhood socioeconomic status demonstrate differences in mathematics outcomes associated with other factors known at kindergarten entry. With regard to prior level of achievement, the findings of this study indicate that interim assessments may yield important insights into the mathematics achievement status and

growth of students in early elementary grades K-2. It is important to note, however, that kindergarten readiness coupled with interim assessment data may also provide further understanding of within group mathematics achievement status and growth.

Consequently, examining variation within groups and placing a greater emphasis on the educational opportunities, interventions, and resources that benefit students from different backgrounds may hold potential for improving equity in early mathematics learning and outcomes.

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CURRICULUM VITAE

Faneshia McPherson Jones

EDUCATION

Eastern Kentucky University
Master of Arts in Educational Leadership 2011
Rank I and Level II School Principal Certification, All Grades
Instructional Leadership Supervisor Certification
School Superintendent Certification

Eastern Kentucky University
Master of Arts in Teaching 2005
Rank II Certification for Middle Grades (5-9)
Mathematics and Social Studies

University of Louisville
Bachelor of Science in Sociology 1998
Minor: Administration of Justice

PROFESSIONAL EXPERIENCE

Kentucky Department of Education Frankfort, KY
Educational Recovery Leader 2019-Present

Jefferson County Public School District Louisville, KY
Assistant Principal 2012-2019

Kentucky Department of Education Frankfort, KY
Educational Recovery Specialist 2009-2012

Danville Independent Public School District Danville, KY
Mathematics Teacher 2007-2009

Jessamine County Public School District Nicholasville, KY
Mathematics Teacher 2004-2007

Kentucky School for the Deaf Danville, KY
Program Coordinator 2001-2004

RELATED ACTIVITIES

Kentucky Department of Education

What Works Kentucky—Cohort 1

Training program for school and district leaders to improve research and data analysis skills.

National Institute for School Leadership (NISL)

LEAD Kentucky

Research-based professional development program to train and support educational leaders to advance the pace of reform in Kentucky.

American Educational Research Association (AERA)

Equity and Inclusion Committee – Division L

Organize and plan events that showcase the breadth of scholarship, perspectives, theoretical approaches and methodologies that are non-dominant and/or utilized by scholars from historically marginalized communities.

PROFESSIONAL MEMBERSHIPS

Kentucky Association for School Administrators

Jefferson County Association of School Administrators

American Educational Research Association

Association for Supervision and Curriculum Development