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District-based and School-based Variables Predicting Performance of High Schools in Arkansas

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DISTRICT-BASED AND SCHOOL-BASED VARIABLES PREDICTING PERFORMANCE OF HIGH SCHOOLS IN ARKANSAS

by

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DEDICATION

I would like to end this journey exactly where I started, surrendered to the perfect will of God. The word of God teaches us,

> Do not err, my beloved brethren. Every good gift and every perfect gift is from above, and cometh down from the Father of lights, with whom is no variableness, neither shadow of turning. Of his own will begat he us with the word of truth, that we should be a kind of firstfruits of his creatures (*King James Version,* James 1:16-18).

Unlike the premises of this study, I have only known God to be a constant and unwavering force in my life. There is no variableness in Him. There is no chaos or confusion. And through His grace, we are each birthed through the word of truth. God has truly gifted me with an incredible opportunity in this life. I can only hope the firstfruits produced from this journey somehow find their way back to His kingdom for a higher purpose and calling than anything I could hope to bring Him on my own. It is only fitting that this journey of wisdom end where all wisdom began, in the fear of Him through which are hidden all the treasures of wisdom and knowledge. And so I dedicate this journey to the One who first called me to it, even when I could not see the path clearly on my own. “Now unto the King eternal, immortal, invisible, the only wise God, be honour and glory for ever and ever. Amen.” (*King James Version,* I Timothy 1:7).

ABSTRACT

by
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December 2020

Title: District-Based and School-Based Variables Predicting Performance of High Schools in Arkansas (Under the direction of Dr. David Bangs)

The purpose of this dissertation was to determine the predictive effects of school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates. These predictive factors were examined on persistence as measured by the 4-year graduation rates, on accountability ratings as measured by the ESSA building score, and on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas, respectively. A quantitative, multiple regression analysis was used to analyze the data. The sample data for this study comprised 75 Arkansas public high schools, selected and stratified by size and geographic locations, throughout the state of Arkansas. An alpha level of .05 was set for the two-tailed test for each of the three hypotheses. Health literacy was the only single predictor that contributed significantly to the models regarding the criterion variables of accountability ratings as measured by the ESSA building score and on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas. No other significance was observed. Using the chaos theory as the theoretical framework, this study not only complemented existing

literature but created new literature and research to better understand health literacy and its predictive effects on certain school-based outcomes. Because of this research, policymakers should reexamine the current achievement goals used in school accountability processes to produce a more equitable accountability scale for schools across state and national levels.

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CHAPTER I

INTRODUCTION

The concept of education and how a society provides such has continually evolved since the beginning of recorded human history. What was once a concept or attainment discussed around the table at home is now configured and debated on a national stage throughout all Western civilization. The federal government first created the United States Department of Education (2019) in 1867, after legislation was signed into law by then-President Andrew Johnson. Under this legislation, the noncabinet department's primary purpose was to collect information and statistics about schools throughout the United States. After concerns arose over federal control of education, the United States Department of Education (2019) was demoted to the Office of Education in 1868. This division of the United States government would not reach department status again until 1979 when President Jimmy Carter signed legislation that not only reinstated the department but officially established the United States Department of Education as part of the executive branch of the United States government (United States Department of Education, 2019). Since this time, the United States Department of Education has grown into one of the most extensive and most costly branches of the United States government.

Throughout the last half-century, leaders within these governmental bodies have enacted policies and changes to the educational landscape to bring about equality, close achievement gaps between special populations, and protect the most vulnerable within the system. Recently, the notion of accountability has risen to the forefront of public education throughout the United States and other Western societies. As these societies began to compete against one another for the most productive system of education, accountability began to shape how education was delivered in the nation's schools. In 2015, the Every Student Succeeds Act (ESSA) was signed into law by President Barak Obama (United States Department of Education, 2019). This legislation gave the federal government the power to create specific guidelines for public schools directly attached to school funding and challenged every state to create ESSA legislation to accomplish goals set forth by the federal government.

Within ESSA legislation, the federal government requires each state's lawmakers to create a system that holds schools and districts accountable for student achievement and persistence rates. Leaders from the State of Arkansas submitted an initial ESSA plan to the United States Department of Education in 2017 (Arkansas Department of Education, 2018). The United States Department of Education officials approved the plan in January 2018, and the accountability plan therein became retroactive for the 2017-2018 school year (Arkansas Department of Education, 2018). School district leaders throughout the state made plans to implement the needed guidelines under the state's new ESSA business rules. Two years later, leaders from the State of Arkansas amended the state's ESSA plan once again to the current form in practice today.

As education has evolved throughout history, so has how societal leaders value aspects of education. With the continued challenges from governmental bodies, the pendulum shifts of politics, and budget concerns, the ability of school leaders to develop data-driven teams that can predict student and school success is a coveted resource. If certain phenomena can be predicted by a set of predetermined factors or variables, school leaders may be able to plan for the future of student success, while meeting the growing demands from accountability policymakers. This study was designed to contribute to best practices of school leadership and decision-making.

Statement of the Problem

There were three purposes to this study. First, the purpose of this study was to determine the predictive effects of school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on persistence as measured by the 4-year graduation rates for high schools in Arkansas. Second, the purpose of this study was to determine the predictive effects of school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on accountability ratings as measured by the ESSA building score for high schools in Arkansas. Third, the purpose of this study was to determine the predictive effects of school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas.

Background

Theoretical Framework: Chaos Theory

Educational professionals in 21st-century America no longer solely assume responsibility for content acquisition, but also for addressing adversity gaps and social issues within the educational system to produce children wholly and equitably capable of success. To hold educational institutions, educators, and leaders accountable, legislators within this nation's government have created an environment of high stakes testing as the measure by which these goals are frequently evaluated (Au, 2017). Professionals within education, however, often argue the myriad of factors that influence the level of success on these tests such as poverty, home life, and societal inequities. Lampert (1985) viewed the teacher as a *dilemma manager* or mediator of diverging interests, who builds upon a working identity that is purposefully ambiguous. She contended that schools could not separate content or subject knowledge from the social issues facing students. These social issues produced inequitable gaps among student achievement and persistence rates, which then created inequitable gaps in modern schools in the United States.

Education professionals seek to use chaos theory to give a new pattern of practice and thought in 21st-century education. Like the theory's scientific counterpart, chaos theory was used to explain complex systems that often appear to behave randomly but work within an underlying structure of order (Smith, 2007). Because education is part of the universe in which people live, the system is, by default, subject to chaos theory in the same way the physical realms of sciences would be subject to chaos theory (Lorenzen, 2008). Student and learning outcomes, therefore, cannot be random but rather are dependent upon an initial condition already present in the network that leads to a particular outcome or phenomena. The conceptual foundation for chaos theory's applicability in education is one of practicality and growing acceptance.

Although educators may not be able to control the universe, educational leaders can use chaos theory to describe outcomes and systems within their educational environment and thus predict, in part, the influence of certain factors on student and school performance. Researchers may now have the ability to scientifically predetermine a set of predicted results for any phenomenon in question based on potential influences, specifically those chosen for this study (school size, teacher absenteeism, pupil-teacher ratio, health literacy percentage by district, and highly mobile student population rates by school) on particular phenomena such as 4-year graduation rates of schools, ESSA building level scores of schools, and the average junior ACT composite score of schools.

School Size

School size has long been an issue of contention among educators and policymakers in the United States. The bulk of previous research indicated that most studies of school size have historically concentrated on the relationship between an institution's size and the costs of providing the education therein (Bradley & Taylor, 1998). Furthermore, historical gaps also exist in how a school's size influences or affects student achievement and the overall performance of a school, as indicated by local or national accountability measures (McMillen, 2004). School size as a predictor of student outcomes, such as persistence and achievement rates, is still a valid research topic for any professional in the educational field to examine. However, to understand the full effects of whether school size is a significant predictor of student outcomes, using school size in combination with other variables or covariates could provide greater insight. Coupling school size with predictors such as pupil-teacher ratio, an indicator of class sizes, and highly mobile student population rates (another indicator of students in poverty), allowed for balanced data for analysis.

Teacher Absenteeism

Until the last 20 years, researchers largely ignored the exploration of teacher absenteeism as a factor affecting educational processes in the United States. Barber and Mourshed (2007) argued the increase in popularity of studying teacher absenteeism could be attributed to a growing cultural recognition that teacher professionalism and qualification are two of the most important factors accounting for the quality of education. Since this time, the concept of teacher absenteeism has become a heavily researched topic of interest for educational leaders and policymakers. If teacher absenteeism can be linked to lower student achievement, educational decision-makers may be able to use the data to help curb chronic absentee practices and create policies that might more consistently keep teachers in the classrooms. Chronic teacher absenteeism now affects one in every four teachers across the United States (Viadero, 2018). The study of teacher attendance rates has become increasingly popular among researchers attempting to discover how the nation's educational system might improve relative to competing countries.

Pupil-Teacher Ratio

Advancing opportunity for student achievement is a priority for many governing bodies in the educational world. In the past, researchers have tended to show a difference in student achievement associated with class size (Blake, 1954; Coleman, 1971; Glass & Smith, 1979). However, most research, not in conflict with these findings, often indicated class size had slightly significant to less than significant effects on student achievement (In-Soo & Chung, 2009). Although some studies indicated initial, positive effects of small pupil-teacher ratios in lower-level classrooms on student achievement, the strength of these effects typically tapered over time (Nye, Hedges, & Konstantopoulos, 2001). The results indicated that lower pupil-teacher ratio led to higher achievement scores for students only briefly and then waned over time. Because these findings have such mixed results, using this predictive factor in my research may clarify its effect on student achievement and persistence.

Health Literacy

The concept of health literacy has quickly risen from near-total obscurity to a prevalent issue between healthcare and governmental institutions. In the first decade of health literacy research, the results of several studies indicated adverse events as claimed in a report by the Joint Commission of Healthcare Organizations (2007). This commission's findings were among the first to associate low heath literacy rates to adverse educational events clearly. If low health literacy rates could be affected by education as early findings in this report have indicated, perhaps, the reverse could also be true that health literacy affects learning. Due to a lack of research between health literacy and student achievement and persistence, minimal direct effects have yet to be discovered. However, newer research has indicated some association between health literacy rates and student underachievement.

Highly Mobile Rates

The concept of highly mobile students has long been an issue among public-school systems throughout the United States. Two distinct types of student mobility are defined in the research. The ERIC Clearinghouse on Urban Education (1991) described these types of student mobility as inner-city mobility and intra-city mobility. Students highly mobile under inner-city mobility tend to move due to job fluctuations in the markets (ERIC Clearinghouse on Urban Education, 1991). Students highly mobile under intra-city mobility tend to move under upward mobility due to high rental rates, poor housing conditions, or economic hardships (ERIC Clearinghouse on Urban Education, 1991). Popp, Stronge, and Hindman (2003) created six categories of student mobility, including students on the move, children living in high poverty, migratory children and youth, students experiencing homelessness, children of military families, and students experiencing mobility on a global scale. Whichever category within highly mobile students fit, campuses and districts are required to educate and provide services to these students under the same accountability guidelines for student persistence and achievement as set forth by federal, state, and local policymakers. To determine the effects of highly mobile rates of these student populations on persistence and achievement rates, this scenario often requires schools to take on the role of data collection and research themselves.

Hypotheses

The following hypotheses were considered in this study:

1. No significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on persistence as measured by the 4-year graduation rate for high schools in Arkansas.
2. No significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on accountability ratings as measured by the ESSA building score for high schools in Arkansas.

3. No significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas.

Description of Terms

American College Testing (ACT) composite score. An ACT composite score consists of an average of scores taken from four subtests (reading, English, mathematics, and science) after each of the subtests is converted to an interval score ranging from 1 to 36 (ACT, 2019). Composite scores are rounded to the nearest whole number. Fractions less than one-half are rounded down, and fractions greater than one-half are rounded up (ACT, 2019). ACT composite scores are used in at least 17 states as part of a state's standardized testing plan (Princeton Review, 2019).

Arkansas Department of Education. The Arkansas Department of Education began operating as the Arkansas Division of Elementary and Secondary Education (DESE, 2019) in the fall of 2019.

Chronic teacher absenteeism. For this study, chronic teacher absenteeism was defined as a teacher missing 10 or more days of school per year due to sick or personal leave (Griffin, 2017).

ESSA School Index Scores. According to the Final Business Rules for Calculating the 2018 ESSA School Index Scores published by the DESE (formerly the Arkansas Department of Education), ESSA high school index scores are school accountability scores that represent the sum of the following weighted indicators:

weighted achievement scores (35%), school value added growth scores (35%), adjusted cohort graduation rates (15%), and school quality and student success factors (15%) (Arkansas Department of Education, 2018).

Graduation rate. The graduation rate is calculated by taking the number of cohort members who earned a regular high school diploma by the end of the school year 4 years after the year the cohort was established and dividing the number by all members of the established cohort (Arkansas Department of Education, 2019). The initial cohort is adjusted by the number of students who have transferred in during the 4-year cohort timespan and the number of students who have transferred out to another public school, immigrated to another county, transferred to a prison or juvenile facility, or died during the 4-year cohort timespan (Arkansas Department of Education, 2019).

Highly mobile student. According to the Final Business Rules for Calculating the 2018 ESSA School Index Scores published by the Division of Early and Secondary Education (formerly the Arkansas Department of Education), highly mobile students are defined as students who are not continuously enrolled in a particular school on or before October 1 through the date of state accountability data report for regular or alternative statewide-assessments (Arkansas Department of Education, 2018).

Highly mobile student population rate. Though the highly mobile student percentage rate may not be a stand-alone, a definition is needed to understand the components of the following study. The Arkansas DESE currently has no standardization for data collection and publishing of highly mobile student population rates. However, a public database called My School Info that is published by DESE does contain data of students who fit the highly mobile student terminology using the term *homeless,* including the encompassing term of *unaccompanied youth* (DESE, 2020). Under this alternate data collection and for this study, highly mobile student population rate was defined as the percentage of those students who lack a "fixed, regular and adequate nighttime residence" (DESE, 2020, para. 1). In general, this includes youth "living in hotels, motels, camping grounds, cars, parks, abandoned buildings, sharing housing of others persons due to loss of housing in economic hardship, or similar settings due to lack of alternate adequate accommodations" for each individual high school (DESE, 2020, para. 3).

Health literacy. According to the University of North Carolina at Chapel Hill (2014), health literacy refers to the "ability to obtain, process, and understand the information needed to make health decisions" (para. 2). The skills required to complete these tasks include reading, writing, listening, asking questions, doing mathematics, and analyzing facts (Arkansas Department of Health, 2013). Health literacy is not only a reflection of an individual's skills and abilities but also how well health systems provide information and services, often categorized regionally by location (University of North Carolina at Chapel Hill, 2014).

Health literacy percentage. According to the United States Health Literacy Map from the University of North Carolina, health literacy percentage is determined from predictive models based on the National Assessment of Adult Literacy using the information to determine a mean score between 0-500 (Lurie et al., 2009). These scores have four categories: Below Basic (0-184), Basic (185-225), Intermediate (225-309), and Proficient (310-500) (University of North Carolina at Chapel Hill, 2014). The percentage is calculated from those scoring above the mean score of 225 (University of North

Carolina at Chapel Hill, 2014). For this study, a low health literacy percentage is calculated when the population reaches below 60%, scoring at or above the mean score of 225.

Pupil-teacher ratio. A pupil-teacher ratio includes the number of students who attend a school divided by the number of certified teachers at the school (Arkansas Department of Education, 2019). The number of certified teachers used in this calculation does not necessarily refer to classroom teachers and may include facilitators, counselors, and administrators.

School size. In Arkansas, school size is defined by the Arkansas Athletics Association (2017). This study divided the schools into the following three grouping categories: small schools (1A-2A) ranged in average student enrollment 0-290, medium schools (3A-4A) ranged in average student enrollment from 291-857.33, and large schools (5A-7A) ranged in average student enrollment from 857.34-2,413 (Arkansas Athletics Association, 2017).

Significance

Research Gaps

An examination of literature attempting to link specific predictive factors to student achievement yielded few definitive studies. The results of this study may help close the gap in what is available by other researchers who have attempted to link non-related factors to student persistence, school performance, and student achievement. Of the factors used in this study, school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and district highly mobile student percentage, healthy literacy posed the highest risk as gaps in the research were quite large. While health literacy has been a topic of concern, the association between health literacy rates and education has only garnered attention in recent years. This gap in research is very evident from the literature review but should not be dismissed as a possible predictor of student success. In addition, school size and poverty tended to be linked together in most of the research conducted on its influence on student achievement and persistence rates. While this posed a smaller risk for research gaps, the frequent combination is still worth noting.

Possible Implications for Practice

With the recent implementation of the ESSA in 2015, replacing the No Child Left Behind Act of 2001, school accountability has begun to branch out into areas not directly related to classroom teaching and learning. In 2017, the Arkansas Department of Education (now DESE) published a first-of-its-kind school grade report based on the newly approved state ESSA plan, with only 70% of the determinant factors directly related to student achievement and growth on standardized testing. With the continuance of public accountability, school districts across the state are redefining educational goals and determining how to meet the needs of students and accountability standards from the state department of education. The predictive variables used in this study are combined to determine the predictive effects of outcome variables specific to the Arkansas ESSA plan, making this study unique, timely, and relevant to district personnel and policymakers within the legislature and DESE. Therefore, school leaders who cannot budget for factors such as lower pupil-teacher ratios may benefit from continued research on the effects on student achievement as compared to the costs of class size reductions. This study's completion could help expand conversations on school accountability and how predictive factors of student success could help shape those conversations and accountability measurements moving forward.

Process to Accomplish

Design

A quantitative, multiple regression strategy was used in this study. The independent or predictive variables for Hypothesis 1 were school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates. The dependent or criterion variable for Hypothesis 1 was persistence measured by the 4-year graduation rate for high schools in Arkansas. The independent or predictive variables for Hypothesis 2 were school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates. The dependent or criterion variable for Hypothesis 2 was the accountability rating as measured by the ESSA building level score for Arkansas high schools. The independent or predictive variables for Hypothesis 3 were school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates. The dependent or criterion variable for Hypothesis 3 was the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas.

Sample

The population for this study included existing data from Arkansas public high schools, excluding virtual schools and special multi-area schools for alternative learning or juvenile detention centers. A stratified random sampling was taken from Arkansas' public high school data sets for 2018. Data from 75 schools were selected and stratified by size: 25 schools were 2A or below, 25 schools were 3A or 4A, and 25 schools were 5A and above. Also, the population was stratified by geographic location throughout the state of Arkansas: 15 schools from each of the five regions (Central, Northwest, Northeast, Southwest, and Southeast). The 75 schools selected helped to ensure the populations of public high schools in the state were represented with equity. All criterion variable data were collected from the 2018-2019 school year.

Instrumentation

In 2019, the 4-year graduation rate of public schools in Arkansas was determined by federal ESSA standards developed from ESSA law in 2015. The graduation rate was calculated by taking the number of cohort members who earned a regular high school diploma by the end of the school year 4 years after the year the cohort was established and dividing the number by all members of the established cohort (Arkansas Department of Education, 2019). Then, the initial cohort was adjusted by the number of students who transferred in during the 4-year cohort timespan and the number of students who have transferred out to another public school, immigrated to another county, transferred to a prison or juvenile facility, or died during the 4-year cohort timespan (Arkansas Department of Education, 2019).

In January 2017, the federal government approved Arkansas' ESSA plan. According to the plan, each high school would receive a score based on specific components. These scores would then be converted to letter grades based on algorithms developed by the state department and could fluctuate from year to year (Arkansas Department of Education, 2018). Though converted, the calculated score did not change and was used as the criterion variable of Hypothesis 2. The school quality and student success component was calculated by taking the number of students achieving the school quality and student success and dividing by the total number of students involved (usually by grade or overall number testing). The subcomponents of the school quality and student success score consisted of reading achievement on the ACT, science achievement on the ACT, science growth on the ACT from the previous year, on-time credits for each classification, high school GPA for seniors, ACT component, ACT readiness benchmark component consisting of a score of 22 or above on the ACT reading, AP/IB/Concurrent credit component, computer science credit component, and service-learning credit component (Arkansas Department of Education, 2018). After each of the four major components of ESSA were calculated, each significant component score was multiplied by the determined multiplier and added together for an overall ESSA score for the school building (Arkansas Department of Education, 2018).

In 2019, all Arkansas public high schools were required to administer the ACT to juniors in their building. Juniors and their guardians could legally opt out of the testing administration with a signed waiver (Arkansas Department of Education, 2018). However, all public high schools in the state had to give all students in Grade 11 the opportunity to take the college entrance exam. According to the DESE (2020), the ACT has "long been recognized as one of the leading college entrance exams" (para. 2) and can be used to provide a longitudinal approach to education and career planning, a central component of the state's ESSA plan. The ACT testing instrument used in the state consists of four area subtests: reading, English, mathematics, and science. The recent addition of a writing subtest was not required in the state of Arkansas. The ACT has a reliability score in reading of .87, English of .92, mathematics of .91, and science of .85, and an overall composite reliability score of .96 (ACT, 2019). The ACT exam consists of a total of 215 items in limited-timed areas. The reading subtest consists of 40 questions with a 35-minute limit; the English subtest consists of 75 questions with a 45-minute time limit; the mathematics subtest consists of 60 questions with a 60-minute time limit, and the science subtest consists of 40 questions with a 35-minute time limit (ACT, 2019). An average composite score of all juniors who tested during the state-administered ACT window in high schools was then calculated as an average ACT composite score for the school.

Data Analysis

To address each of the three hypotheses, I conducted a multiple regression using the following predictive variables: pupil-teacher ratio, teacher absenteeism, district health literacy percentage, school size, and highly mobile student population rate. The criterion variables of the three hypotheses were the 4-year graduation rate of Arkansas high schools, the ESSA building level score for Arkansas high schools, and the ACT composite score of juniors in Arkansas high schools, respectively. As is common in educational and sociological studies, an alpha level of .05 was set for the two-tailed test of each null hypothesis.

Summary

As educational professionals continue to balance the work of various noninstructional factors of education that may influence student persistence and achievement with the numerous changes to local, state, and federal accountability efforts, the frequencies of studies such as the one conducted in this dissertation will likely increase. School leaders will continue to find themselves in the role of researchers as they collect, interpret, and understand the implications of the data. To fully understand this study, a literature review of the predictive factors on student achievement and persistence, in addition to the theoretical framework, was conducted and placed in the next chapter of this dissertation. The review of literature created the foundation upon which the study would be based and was salient to understand the past and future need for educational research in the following areas.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

I designed the following literature review to provide an examination of related literature. I sorted the review into six categories. First, the theoretical framework established the conceptual foundation of the study. This foundation included a historical review of chaos theory and how the theory's evolution over time applies to education to predict certain phenomena. The remaining five categories were grouped by the same five predictive variables from each of the three hypotheses: (a) school size, (b) teacher absenteeism, (c) pupil-teacher ratio, (d) health literacy, and € highly mobile students. Finally, these categories were characterized by research trends, each containing a section related to statistically significant research as related to student achievement and persistence as well as school performance and accountability ratings. I also included other factors in the literature review, such as repeatedly used covariates, major research projects on the topic, and patterns of thoughts.

Theoretical Framework: Chaos Theory

The theoretical evolution of the philosophical and the physical settings have often created environments in which mathematicians and scientists alike could study the world. One such methodical theory is chaos theory, birthed from the concept of *sensitive dependence*, which was later defined as phenomena in which the physical axioms and like antecedents create violated consequences (Maxwell, 1876/1925). Though chaos has been customarily applied to the mathematical process of a *dynamical system,* as founded by Sir Isaac Newton, the roots trace back to variations of Aristotle's views on what is today referred to under Maxwell's definition of sensitive dependence (Oestreicher, 2007). This fundamental idea that deviating from a process, truth, or method can have a significant influence on the intended outcome or result was the foundation upon which chaos theory was initially established. As such an established theory, early scientific predictions helped to solidify chaos theory's place within the realm of science and mathematics.

One of the early predictions connected to chaos theory occurred by applying Newton's laws of motion to celestial bodies. To calculate or predict a planet's movement, Newton argued that the causality principle and the laws of motion each had to be considered separately (Oestreicher, 2007). What resulted was a simplified model that led future mathematician and astronomer, Pierre-Simon Laplace, to reduce the entire study of planets to a series of mathematical equations that demonstrated the totality of all then-known celestial bodies (Oestreicher, 2007). Laplace would later define the concept of determinism, a philosophic hypothesis that physical phenomena are determined by a chain of unbroken prior conditions (Oestreicher, 2007). Science and philosophy had now come together under determinism as what would be described as predictability based on the scientific principles of causality (Oestreicher, 2007). The evolution of these scientific ideas and concepts as valuable to the philosophical world has been documented throughout history. This evolution of science and philosophy would later influence Henri Poincare and his work.

As with most scientific inquiry and theories, chaos theory assumes order behind seemingly random events. Chaos theory, as founded by Henri Poincare, was used in the exploration of evolved mathematical concepts to understand physical systems (Smith, 2017). The *principle of causality,* which is considered one of the foundational principles of physics today was derived from Rene Descartes' (1641/2013) philosophy as published in his *Third Meditation* in 1641, which has been translated to read "Nothing comes from nothing" or "Every effect has a cause" (pp. 48-49). Astronomers of the 17th century used the principle to note that patterns could predict the trajectory of the planets (Oestreicher, 2007). Mid-19th-century scientist, James Clerk Maxwell, applied statistical physics to determine the motion of gases (Maxwell, 1876/1925). All of which became integral pieces for Poincare's chaos theory, assigning an order to what was once deemed random events. Order, as noted from chaos theory's inception, is key to understanding the often-misunderstood and occasionally ill-defined chaos theory.

While accurately defining chaos theory, Poincare pointed out that the scientific community has not always welcomed chaos theory. Bishop (2017) wrote that most scientists tend to treat theories as *bodies of knowledge* that provide predictions or explanations of phenomena in a systematic environment. When scientists attempt to move from the general to the precise, however, differences emerge on how to conceptualize the theory in question. Today, most agree that chaos theory can be used to help predict outcomes based on variables, though not always with the precision desired.

As chaos theory evolved, these same concepts were applied in areas outside of physical sciences. Levy (2007), from the University of Massachusetts at Boston, illustrated a simulated scenario in which chaos theory could be applied. In his scenario between the manufacturers of computers, the supplies, and the market, Levy was able to determine how managers could underestimate the cost of international production and argued the chaos theory as the theoretical framework for the scenario prediction model. Professionals used chaos theory here to predict outcomes to phenomena in a social, business setting outside of the physical scientific world.

Real estate brokers also learned how to calculate and apply the principles of chaos theory to their business models. The business world expanded chaos theory in economic practices to explain housing market data in the recent housing crisis that struck this nation roughly a decade ago (Smith, 2017). When real estate professionals applied chaos theory, predictions led to determinations in when and where the housing market could see growth and rising prices. These professionals were then able to concentrate their efforts on the areas of predicted growth to keep business and careers afloat during the housing crisis. Chaos theory may still lead to some uncertainty; however, the environment created also results in opportunities for growth and change.

Business models are not the only applicable industry for chaos theory. Richards (1990) studied the application of chaos theory in collective decision making in the late 20th century. She examined the structure of interdependency in strategic behavior based on the actions and choices of others through the chaos theory theoretical framework. Richards argued that if the decisions of an individual or certain subgroup were contingent upon the actions of another individual or subgroup, the possibility of predicting the outcome of the decision process could be accomplished by using the chaos theory model. This application would have lasting effects on the social sciences regarding the implementation of chaos theory.

In the United States in the 1980s, Magdalene Lampert, a George Herbert Mead collegiate professor of education at the University of Michigan, published her dissertation on the practices teachers must employ to teach in the modern classroom titled *How do teachers manage to teach*? *Perspectives on problems in practice*. In the article, Lampert (1985) argued from a practitioner's point of view that teaching was more than merely a list of theorems and practicums but everything in the universe working for, within, and against each other despite the learning initiatives planned by the practitioner. Educators have long since debated the role of the universe, or the idea of variables as an effective filter, in student performance outcomes. The framework behind both her published works was rooted in the chaos theory. The concept of chaos theory as a framework from which to understand and predict educational outcomes would not be exclusive to Lampert.

Using chaos theory as a lens in which educational environments can be viewed and understood has also exhibited fruitful results. Livingston, Bridges, and Wylie (1998) studied two outlier schools in which certain predictor variables created certain outcome phenomena. The results of the study indicated that designating specific predictors could imply the rating of quality performance for a school in terms of qualitative characterizations. Though Livingston et al. investigated qualitative qualities of a school, such as mission and vision, the authors experimented with the possibility of using chaos theory as a viable framework in the social sciences to predict educational outcomes.

Chaos theory has recently been used to establish a rationale for the theory-practice gap in educational research. At the turn of the 21st century, Nuthall (2004) critiqued four types of research on teacher effectiveness and the practicum gap on what he termed *classroom realities.* Nuthall concluded that to be relevant and useful for the educational profession, research must link students' knowledge, beliefs, and skills to continuous, detailed data on students' experiences on an individual or group level. Based on the exploration of connecting the various individual changes in a student's environment and the published research of educational practices and theorems, the ability to bridge the theory-practice gap could prove helpful when viewed from the framework of the chaos theory.

Education professionals seek to use chaos theory to give a new pattern of practice and thought in 21st-century education. Like the theory's scientific counterpart, chaos theory was used to explain complex systems that often appear to behave randomly but work within an underlying structure of order (Smith, 2007). Because education is part of the universe in which people live, the system is, by default, subject to chaos theory in the same way the physical realms of sciences would be subject to chaos theory (Lorenzen, 2008). Student and learning outcomes, therefore, cannot be random but rather are dependent upon an initial condition already present in the network that leads to a particular outcome or phenomena. The conceptual foundation for chaos theory's applicability in education is one of practicality and growing acceptance.

Scientists and mathematicians have used chaos theory, or the founding principles, for centuries to help explain, predict, and prepare for natural phenomena. In the same manner, educational leaders must "prepare for chaos and accept uncertainty as a natural condition" (Lorenzen, 2008, para. 10). Although educators may not be able to control the universe, educational leaders can use chaos theory to describe outcomes and systems within their educational environment and thus predict, in part, the influence of certain factors on student and school performance. Researchers may now have the ability to scientifically pre-determine a set of predicted results for any phenomenon in question based on potential influences, specifically those chosen for this study (school size, teacher absenteeism, pupil-teacher ratio, health literacy percentage, and highly mobile student population rates by school) on particular phenomena such as 4-year graduation rates of schools, ESSA building level scores of schools, and the average junior ACT composite score of schools.

School Size

School size has long been an issue of contention among educators and policymakers in the United States. Historically, most researchers of school size have concentrated on the relationship between an institution's size and the costs of providing education (Bradley & Taylor, 1998). Furthermore, Bradley and Taylor (1998) asserted that these studies indicated a trend that suggested the costs of operation decline as school size increases. The idea that larger schools have less per-pupil expenditure due, in part, to higher efficiency can be found across spectrums in the education world (Bradley & Taylor, 1998; Howley, Bickel, & Strange, 2000). Unfortunately, the concentration on cost-benefit of school size has left historical gaps in the study of how school sizes influence or affect student performance.

Furthermore, historical gaps also exist in how a school's size influences or affects the overall performance of a school, as indicated by local or national accountability measures. According to Howley et al. (2000), from 1966 to 2000, only 22 research reports defined school size as an essential focus of scientific investigation regarding student performance. Even when the research was conducted on school size, a covariate of poverty was often found within the study. The results cannot stand entirely alone regarding the influence of a school's size on performance measures. Since Bradley and Taylor's research was published in 1998, research has been developed over the past 2 decades to fill in these noticeable gaps in the literature.

Small-School Movement

A review of literature on school size would be incomplete without describing the contemporary small-schools movement. Semel and Sadovnik (2008) were among the first researchers to claim that the small-school movement within American education can be traced back to the building of alternative schools in the 1960s and small urban school in the 1980s. The research indicated that many of the contemporary progressive educational reforms from the last several decades, especially many in the small-school movement, have their origins in the early child-centered schools. This progressive education sometimes made state and federal legislation and accountability efforts more difficult. Despite the data, Semel and Sadovnik argued that the small-school movement could still succeed, noting the Central Park East Secondary School and Urban Academy as beacons of hope. The research claims by Semel and Sadovnik were rooted in data from another researcher (McMillen, 2004). McMillen (2004) examined the relationship between school size and achievement using longitudinal achievement data from North Carolina. The results indicated that the achievement gap that typically exists between specific subgroups was more significant in larger schools (McMillen, 2004). These results varied across grade level cohorts and subjects. However, the effects of school size on the achievement gaps of certain populations were most notable in mathematics and reading at the high school level (McMillen, 2004). Semel and Sadovnik (2008) believed this study could then be used to argue the success of creating smaller schools in urban areas.

Conflicting Data Research

Before a literature review of school size effects can be documented, an essential piece of information to note is the researchers' motivations and concerns. Howley (1994) pointed out that studies based on outcomes, such as achievement, graduation rates, and attendance, would most likely find positive correlations to smaller school sizes than studies that focused on inputs, such as salaries, staffing, and other economic concerns in a school. Raywid (1999), in an evolved argument, stated Howley's claim on outcome-based research was less likely to recommend smaller school sizes than research based on community values, such as school climate and student participation rates in extracurricular activities. However, Sergiovanni (1994) wrote that researchers and policymakers most concerned with community tended to recommend smaller school sizes for nearly everyone. Those most concerned with outcomes tended to favor smaller school sizes for specific populations, and those most concerned with the financial aspects of size tended to recommend larger school sizes. With research found in each of the categories mentioned above, the importance of a researcher's motive when conducting a study was just as crucial as the indications from the research itself. The argument for smaller school sizes was usually found in research that focused on a result or qualitative measure of community. Researchers whose work focused on outcomes linked to student performance seemed most appropriately matched to the purposes of this study.

Outcomes, such as student performance and student persistence rates, were recently examined in 2015. Researchers evaluated the effects of the introduction of new smaller high schools on student performance in the Chicago Public School District. The project investigated whether students attending small high schools had better graduation rates and student achievement than similar students who attended larger high schools in the district (Barrow, Schanzenbach, & Claessens, 2015). (As a reference, small schools in the state of Arkansas would fall below the 5A category designation from AAA.) Results indicated that students attending smaller high schools tended to persist in school longer but determined no positive effect in regards to student performance as measured by average scores on the ACT exam. These schools were designed using experimental research with the end purpose of publishing the data collected to answer the question of school size's effect on student outcomes. Yet, the results were mixed. Conclusions derived from these results could have lasting effects on predictions made concerning school size and student outcomes for upcoming decades.

A first-of-its-kind study in California that examined the effect of school district size, local school size, and class size on student performance was published in 2001 using data from the California Department of Education. Data sets were isolated relative to school level (elementary, middle, high school) as well as district and school size. Results indicated that school *district* size affected student performance at the middle-level significantly and at the elementary-level slightly, as well (Driscoll, Halcoussis, & Svorny, 2001). However, no significant effects were noted relative to individual *school* size concerning student performance outcomes (Driscoll et al., 2001). Differentiating between the three school levels was a design not previously established by other authors. The notion that each level could have three different indications almost raises more implications for further research than indicated here. Though this study did not account for other possible mitigating factors, such as poverty, the authors claimed that the effects of school size on student achievement could not be ignored in any future research, particularly those with opposing claims.

Furthering Research

Similar research developed at the turn of the 20th century indicated that students in smaller schools could outperform larger schools at all levels, elementary, middle, and high-school. Howley et al. (2000), in partnership with the Matthew Project, published a study that claimed optimal school sizes could be predicted from research data. The study indicated that aggregate achievement data, when all else was equalized, was highest in high schools enrolling 601-900 students. The researchers used principles found in chaos theory to authorize their conclusions. The idea that an optimal school size could predict student outcome scores was not a new concept at this time. However, some earlier, limited literature has been published indicating opposing results, claiming the larger schools have higher student performance rates.

One such piece of literature was designed to determine whether student performance in a secondary school in the United Kingdom, in and of itself, was affected by school size. During their time as professors in the economics department at Oxford University, the authors of the study based their design on new policies implemented in the United Kingdom. Their purpose was to reduce school sizes based on the assumption that smaller school sizes lead to higher student performance and achievement rates (Bradley & Taylor, 1998). These rates were measured by the General Certificate of Secondary Education’s performance scale in which A* to C ratings are given to schools with passing student performance scores. The scale consists of eight rating labels, A*, A, B, C, D, E, and F, the first four of which are considered schools performing on a target level. The results of the study indicated that a nonlinear relationship in the form of an inverted-U did exist in school sizes that could be used to maximize student performance rates (Bradley & Taylor, 1998). These predicted sizes of maximum performance rates were 1,200 for schools with students aged 11 to 16 and 1,500 for schools with students aged 11 to 18. When schools were significantly larger or smaller than the optimal sizes determined, performance rates fell. These estimates garnered from the research are substantially more significant than the average mean size of United Kingdom schools today.

The United States and the United Kingdom are not the only countries to research the effect of school size on student outcomes. Italian researchers published a study in *Socio-Economic Planning Sciences* in 2018 on this topic (Giambona & Porcu, 2018). Giambona and Porcu (2018) claimed that if smaller schools are associated with higher student achievement at the primary level, this same conclusion could not be clearly stated for secondary schools. The study provided empirical evidence highlighting that the effect of size on performance at the secondary level often consists of mixed results. Previous studies have indicated higher achievement among students enrolled in smaller schools, and other studies have indicated higher achievement in very large schools. Still, other studies have suggested a nonlinear relationship between school size and student performance, such as the one conducted by Bradley and Taylor (1998). A covariate associated with student performance success, such as poverty, was used in the study.

School Size with Poverty Covariate

When Howley et al. published their work in 2000, their results differed from The Matthew Project's view on school size as a predictive indicator of achievement scores.

The Matthew Project studies, taking a somewhat different approach, concluded that optimal school size for performance achievement is contingent upon the socioeconomic status of the community that makes up the school (Howley et al., 2000). The socioeconomic status of students has long been a topic of research. However, the added socioeconomic component of poverty can be such an effective predictor of student performance as an individual factor that many studies have used poverty as a covariate to school size when determining effects on outcomes to balance the results.

In addition to larger states and cities in the United States who have partnered in research to examine the effects of school size on student outcomes, smaller states have recently begun researching their own. The Kansas Association of School Boards partnered with Carter (2017) to investigate the results of statistical analysis from the 2015-2016 Kansas State Assessment scores to determine the extent to which a school's enrollment size coupled with the percentage of a school's free or reduced-cost lunch eligibility predict student achievement. The study indicated that larger schools (for reference, those designated as 5A and above by AAA in the state of Arkansas) within the state of Kansas tend to have lower overall average assessment scores than smaller school counterparts throughout the state (Carter, 2017). Many educators, in smaller states like Kansas and Arkansas, tend to believe larger schools generally produce great opportunities for students and higher performance rates on state assessments than smaller schools. However, when poverty was used a covariate, the results from the Kansas study indicated the opposite of this claim, that smaller schools perform at higher rates than larger counterparts (Carter, 2017). Understanding how predictive variables interact with one another is essential to designing a study that produces unbiased results. Using covariates was one way Carter was able to argue his claim.

Teacher Absenteeism

Until recently, the exploration of teacher absenteeism as a research topic has been ignored. In roughly 2 decades, teacher absenteeism has gone from a seldom explored topic of research to a popular, and often, triggering topic of important significance across the world of academia and politics alike. According to Miller, Murnane, and Willet (2007), policymakers' concern with teacher absence rests on three premises. The first premise is that a significant portion of teachers' absences is discretionary. The second premise is that teachers' absences have a substantial influence on productivity. Lastly, policymakers presume that likely policy changes could reduce rates of absences among teachers (Miller et al., 2007). In the current cultural climate, the idea of chronic teacher absenteeism is viewed as a lack of professionalism, contributing to the growing number of strained budgets and inefficient use of resources across school systems in Western society (Joseph, Waymack, & Zielaski, 2014). School leaders and policymakers of today not only attribute chronic teacher absenteeism to unprofessionalism; they often directly relate such characteristics to factors that influence low student achievement.

An Education Week blog post recently interpreted data from a collection regarding teacher absenteeism by every state within the United States to determine the prevalence of chronic teacher absenteeism and its effect on school systems and student performance. The data indicated nearly 28% of teachers nationwide could be labeled as having chronic absenteeism, or absences totaling more than 10 days per school year, during the 2015-2016 school year (Viadero, 2018). Viadero (2018) also discovered that the average level of absenteeism had increased from the previous 2013-2014 data collection. The Civil Rights Data Collection taken from the Bureau of Labor Statistics in 2016 and the data's interpretation by Viadero only included sick or personal leave time, and thus excluded time for professional development, field trips, and other off-campus, school-sanctioned activities. With chronic teacher absenteeism now claiming one in four teachers across the United States, such a topic of interest becomes increasingly popular among researchers in a quest to discover why the nation's educational system is floundering among competing nations.

Traditional Differences

An essential note within any literature review of teacher absenteeism must be the fact that most researchers have focused on traditional public schools. Most studies on the topic of teacher absenteeism consist of data gathered entirely from these types of settings. Fordham University's senior research and policy associate, Griffin (2017), published a paper regarding chronic teacher absenteeism in the traditional public-school setting as compared with chronic absenteeism rates among teachers in the charter school setting. Like in Viadero's (2018) work, professional development and school-based activities were excluded from the data. The results indicated significant gaps between the two institutional settings. In his findings, Griffin (2017) determined that over 28% of teachers in traditional public-school settings nationwide were chronically absent from work. In comparison, just over 10% of teachers in charter schools nationwide were chronically absent. In 34 of the 35 states with sizable charter systems, including all 10 of the nation's largest cities, teachers in traditional public schools were more likely to be chronically absent than teachers working in charter schools. From this data, Griffin then argued that if policymakers were going to hold schools accountable for chronic student absenteeism under ESSA, they must also hold schools accountable for their teacher absenteeism rates as well.

In addition, Griffin (2017) also inquired how the data collected, and subsequent results, differed between those institutions with collective bargaining or unions and those without collective bargaining or unions. The research indicated that chronic absenteeism gaps between teachers in traditional public schools versus charter school were the largest in states where traditional public-school districts are required to bargain collectively. Chronic absenteeism also increased among unionized charter schools in comparison with nonunionized charter schools as well. While not directly related to this study, a proper literature review could not be established without including this covariate of collective bargaining. No investigation was currently found to exist that tested data of only traditional, nonunionized public schools across the nation, causing the literature review to be limited in scope and study.

Statistically Significant

Understanding the prominence of chronic teacher absenteeism is critical for any educational leader or policymaker in making research-based arguments and determining implications on a larger scale. Before these implications and arguments can be fully explored, understanding the effect of chronic teacher absenteeism is even more salient. Raegan T. Miller, former vice president for researcher partnerships at Teach for America, is considered the forerunner of teacher absenteeism effect research after having published his doctoral work from the Harvard Graduate School of Education in 2007. The working paper was a partnership between Miller and his colleagues with the National Bureau of

Economic Research to determine the influence of teacher absenteeism on student achievement (Miller et al., 2007). Though this concept had been previously explored, the topic had never been linked to student achievement on such a prominent scale. By being one of the first researchers to determine the effects of chronic teacher absenteeism on student achievement, the work from Miller's team would become one of the most-cited publications in teacher absenteeism research.

The research conducted by Miller et al.'s (2007) team at Harvard produced longitudinal evidence from a single urban school district in the United States. Adjusting for time-invariant differences among teachers in skill and motivation, the study indicated that for every 10 days a teacher is absent from the classroom, students' mathematics achievement rates drop 3.3% of a standard deviation. Because even small differences in individual student performance rates can have a significant effect on a school's overall performance rating and determination of adequate progress under state and national policies, this effect was determined to be a statistically significant indicator of the effects of chronic teacher absenteeism to student achievement. The implications of this working paper would later lead the Office for Civil Rights in the United States Department of Education to include teacher absenteeism in the biennial Civil Rights Data Collection survey beginning in 2009. This move inaugurated Miller's expertise on the topic for a new generation of educational researchers (Office for Civil Rights, 2020). Researchers would rely heavily on Miller's work to form the basis of new and continued research on the topic hereafter.

Miller, now a prominent name in the research of chronic teacher absenteeism and its effects on student achievement, published his solo work in 2012 under partnership from the Center for American Progress in Washington, D.C. The research, conducted in New Jersey's Camden City Public Schools, indicated that up to 40% of teachers in the district were absent on any given day, contrasting sharply with the national absence average of 3% for full-time salaried employees in the United States (Miller, 2012).In Camden City Public Schools, 38% of the district's middle school teachers were the most chronically absent group, compared to 34% of chronically absent high school teachers in the district, the least likely group to be chronically absent (Miller, 2012). The report by Miller (2012) also indicated that schools with higher portions of African American or Latino populations were disproportionately exposed to chronic teacher absenteeism. Though these numbers indicated higher levels than the national average, Miller's research indicated a growing trend among inner-city schools toward increased chronic teacher absenteeism.

Chronic teacher absenteeism was not without effect on student achievement in Camden City Public Schools. The researcher found effects on student mathematics achievement were like those in the secondary schools in the urban school district from his previous study (Miller, 2012). In addition to lower student performance, Miller (2012) also argued that chronic teacher absenteeism could cost public schools up to $4 billion annually. The concept of linking teacher absenteeism to cost matched a comparable study in North Carolina by Duke University's (Clotfelter, Ladd, & Vigdor, 2009). Clotfelter et al. (2009) indicated through published data that the average cost of raising student achievement by one percentage point was $33 to $36 per student per subject. They went on to argue that a school with a class size of 25 students in which the teacher teaches both reading and mathematics would lose $250 in achievement cost per single teacher absence

(Clotfelter et al., 2009). Miller (2012) and Clotfelter's et al. (2009) teams both produced research that not only linked chronic teacher absenteeism to lower student performance but also to higher education costs, a point not lost on nearly any state or federal budget committee. Porres (2016) used a regression model to link teacher absenteeism as a strong predictor of student test scores after his research indicated the negative effects of teacher absenteeism on student achievement scores on Advanced Placement exams. Students taught by Advanced Placement teachers with chronic absenteeism led to fewer students passing Advanced Placement exams. However, the magnitude of these effects decreased when additional control variables were added to the model. Much of the research on teacher absenteeism since Miller (2012) and Clotfelter et al. (2009) has indicated adverse student achievement effects, the associated costs of such to a public-schools' budget, or both.

Educational decision-makers can use the data linking higher rates of teacher absenteeism to lower student achievement to help curb chronic practices and create policies that could more consistently keep teachers in the classrooms. For example, Griffith (2017) from the Fordham Institute estimates an average of 3 million public-school teachers in the United States teaching at least 50 million students each year. Statistically, 800,000 of these teachers were chronically absent each year, totaling at least 9 million days of school (Griffith, 2017). According to Miller (2012), 5% of public-school teachers are absent each day across the United States. These data create a staggering statistic of nearly 1 billion instances each year in the United States in which a student comes to class in a public-school setting without the teacher of record present.

Policymakers could determine rationales for the absences using anecdotal data from local teachers and seeking to make the environment more conducive for less absenteeism.

Pupil-Teacher Ratio

Pupil-teacher ratio debates are commonplace among educational policymakers. A literature review of the subject reflected the interest among researchers, as well. One of the first synthesized studies on the topic occurred in the middle of the 20th century. A meta-analysis of 85 published studies on the effects of pupil-teacher ratio on elementary and secondary students was conducted in the 1950s (Blake, 1954). From these 85 studies, 35 indicated that smaller class sizes have a positive effect on student achievement. However, 32 of these studies could not support any directional hypothesis. Instead, these studies indicated that no significant effect occurred between pupil-teacher ratio and student achievement. Twenty-five years later, Glass and Smith (1979) also published a meta-analysis on pupil-teacher ratio and student achievement. Seventy-seven studies were analyzed on the effects of pupil-teacher ratio and student achievement. The authors concluded, "Reduced class-size can be expected to produce increased academic achievement" (Glass & Smith, 1979, p. 8). Hedges and Stock (1983) used new and improved analytic methods to reanalyze the work done by Glass and Smith (1979. In the results, the researchers questioned the conclusions made by Glass and Smith due to statistical concerns regarding effect sizes (Hedges & Stock, 1983). The mixed results based on many studies created much debate among researchers. Soon, the debate would be taken to state and national levels where policymakers would begin using data to form educational initiatives and programs.

Like the debate among policymakers, researchers, too, have had to learn exactly to what extent any findings or data can be used in the determination of implications and next steps. Coleman (1971) made this same argument when he published his work on the subject in which he found the same research being used by each side of the pupil-teacher ratio debate. Educators, he found, were much more receptive to the idea that lower pupil-teacher ratio leads to higher student achievement. Schools boards and governmental bodies were not as receptive, in his opinion, despite using the same conclusions. Even in 1971, the Canadian province of Manitoba could have potentially saved over $4 million by increasing the pupil-teacher ratio average from 20.5:1 to 21.5:1 in all the schools (Coleman, 1971). The Coleman Report, as named in the educational field, raised two salient questions for researchers and policymakers. The first question centered on the relationship between pupil-teacher effects and the policies implemented from the interpretation of those data. The second question centered on the significance of the effects of pupil-teacher ratio on student achievement and the strength of the effect size. These questions focused on policy-making, and significance of effects have since been woven through much of the research on pupil-teacher ratio.

Student-Teacher Achievement Ratio Project

One of the most important pieces of literature in the pupil-teacher ratio debate was published from data from a state initiative project established in the 1980s. Tennessee's Student-Teacher Achievement Ratio (STAR) project was an initiative launched by state lawmakers from 1984-1999 (Johnston et al., 1990; Wyss, Tai, & Sadler, 2007). The most recent meta-analysis on the pupil-teacher ratio esteemed the STAR project so influential that the study was divided by STAR and Non-STAR studies

(Filges, Sonne-Schmidt, & Nielsen, 2018). The data collected from the STAR project involved students in kindergarten through third grade and began with more than 6,000 students being randomly assigned to three types of class sizes and tracked over 4 years: small classes (13-17), regular classes (22-25), and regular classes with a teacher's aide (Johnston et al., 1990). Many studies have evaluated STAR and indicated that cumulative positive effects were found in both reading and mathematics at the elementary level (Finn, Gerber, Achilles, & Boyd-Zaharias, 2001; Finn, Gerber, & Boyd-Zaharias, 2005; Hanushek, 1999; Nye et al., 2001). These researchers claimed that the positive effects of pupil-teacher ratio on student achievement were still present after 6 years when students returned to larger classes after the project ended. As these arguments became known, policymakers quickly began developing what has now been termed *class size reduction initiatives* throughout the country.

STAR project data have continued to be analyzed in a variety of ways throughout the past 2 decades with mixed results. Greene (2005) questioned the validity of STAR data due to a lack of pre-tests given to the students before the initiative began. Blatchford (2003) argued that only a small comparison of class sizes had been conducted and suggested the Hawthorne Effect could have skewed the STAR project's data. Filges et al. (2018) concluded from their analysis of the STAR project's data that an effect from pupil-teacher ratio and reading achievement was found, although that effect was minimal. However, the same could not be found regarding mathematics achievement. These mixed results have led many researchers on the topic of pupil-teacher ratio to focus more on effect sizes and less on statistically significant differences. This change in how the data surrounding pupil-teacher ratio and student achievement is observed and reported has transitioned the world of education and policymaking for the near future away from class-size reduction.

Significance of Very Small Pupil-Teacher Ratio and Strength of Effect Size

In place of meta-analyses regarding pupil-teacher ratio and student achievement, modern researchers have tended to focus more on the effect size than those previously. Rice (1999) from the University of Maryland, published a study with similar findings. Her study examined the effect of pupil-teacher ratio on instructional strategies in high school mathematics and science courses. She argued that the pupil-teacher ratio has a more substantial positive effect size on classes with a pupil-teacher ratio of less than 20:1. Rice documented that the negative effect size for the larger pupil-teacher ratio was strongest among classes with higher achieving students. The pupil-teacher ratio's effect size diminished when classes were composed of lower-performing students as teachers were less likely to change instructional practices in these classes. The pupil-teacher ratio, itself, does not appear from newer research to influence student achievement directly. However, modern research does indicate that very low pupil-teacher ratios can lead to differences in instructional practices that lead to higher student achievement.

A 2007 study from the University of North Carolina focused on the influence of high school science class pupil-teacher ratio and student achievement in introductory college science courses (Wyss et al., 2007). The results from 36 public and 19 private institutions from 31 different states indicated through multiple regression analysis that pupil-teacher ratios did not have a substantial effect size on student achievement until the class size fell to 10 or fewer students (Wyss et al., 2007). Wyss et al. (2007) argued that when the pupil-teacher ratio fell to 10:1 or fewer, instructional practices changed, therefore leading to excellent student achievement.

This argument can be found again in a Polish study published in 2013. Koniewski (2013) analyzed the influence of pupil-teacher ratio on academic achievement by using data from the Regional Examination Board in Cracow (Poland) in 2006. The results indicated no statistically significant effect of pupil-teacher ratio on student outcomes. However, students from classes with below 23 students did achieve higher mean scores than their peers from larger classes by a 0.039 standard deviation (Koniewski, 2013). When the pupil-teacher ratio dropped to less than 23:1, instructional practices tended to change as well. These instructional practices lead to higher overall averages on the examination. Similar studies have indicated that this trend is not exclusive to Poland.

Data have also indicated that the pupil-teacher ratio has a significant effect on the costs associated with education. However, many researchers still find difficulty in determining whether the pupil-teacher ratio affects student achievement. Molnar (2000) found that smaller teacher-pupil ratios could lead to a focus on instruction for teachers, an improvement on student behaviors, and more individual attention with opportunity for participation. Strecher and Bohrnstedt (2002) argued under findings from the California Class Size Reduction initiative that at least some instructional practices differed from classes with smaller pupil-teacher ratios than those with larger pupil-teacher ratios. These instructional differences, they argued, lead to higher student achievement. With these benefits in mind, the link between pupil-teacher ratio and student achievement has been attempted.

Health Literacy

In the United States, professionals have spent the last 2 decades refining definitions, research, and implications of health literacy across the many facets of everyday life. While the leadership at healthcare facilities and economic reporting bodies use health literacy as a social issue to combat, leaders in the education arena have been slower to react (Vernon, Trujillo, Rosenbaum, & DeBuono, 2007). Minimal studies exist that directly attempt to discover the influence of health literacy on student achievement. Due to a lack of research between health literacy, student achievement, and persistence, minimal direct effects have yet to be discovered. However, many researchers over the past 2 decades have sought to link the two worlds.

In 2003, the United States Department of Education included health literacy as a component of the annual National Assessment of Adult Literacy for the first time. This 2003 survey indicated that up to 36% of the adult population in the United States had a Basic or Below-Basic health literacy level (Vernon et al., 2007). Vernon et al. (2007) also reported that while minority populations had a lower average rate of health literacy, White, native-born Americans represented the largest segment of the population with Basic or Below-Basic health literacy levels. Even more specifically, nearly 60% of all patients on Medicaid or Medicare displayed Below or Below-Basic levels of health literacy rates. In addition to the health literacy rates, Vernon et al. also estimated the current present-day costs associated with low health literacy rates to be over $3 trillion each year. With initial findings such as these, health literacy quickly became a topic among governmental economic decision-making bodies. These leaders would help ignite the research still being conducted over 15 years later.

In addition to Vernon et al.'s findings, a 2007 report from the Joint Commission on Accreditation of Healthcare Organizations, a group that accredits healthcare organizations and programs throughout the United States, was deemed an early catalyst for health literacy proponents. In the report, the Joint Commission members claimed that patients with lower health literacy rates were at higher risks of preventable adverse events (Joint Commission on Accreditation of Healthcare Organizations, 2007). In 2011, The University of North-Carolina at Chapel Hill commissioned a group of researchers, under contract from the Agency for Healthcare Research and Quality, to conduct a literature review of 86 articles deemed fair to good on 72 unique studies surrounding health literacy. The meta-analysis led researchers to determine that based on conclusions generated, students whose parents had lower health literacy rates spent more time hospitalized than peers with parents having higher health literacy rates (Berkman et al., 2011). Until these reports, professionals had widely viewed low health literacy as solely a patient's deficit. The perception has now led to the recognition of a *systems issue* (Rudd, 2010). Once this shift from patient to systems issue occurred, the research on health literacy was ignited. These studies continue to attempt to link health literacy rates with economic and social effects.

Effect on Culture

Linking health literacy rates to economic and social implications is argued in nearly all research conducted on the topic thus far. Bennett, Chen, Soroui, and White (2009) associated health literacy with a range of poor health-related outcomes such as lower rates of receiving flu shots and other vaccinations in addition to being able to read, understand, and administer medications as prescribed by a health professional. These findings mirrored much of the research from Nielsen-Bohlman, Panzer, and Kindig (2004), who claimed that patients with lower health literacy rates were less likely to seek preventative care and reported lower overall health status than those with higher health literacy rates. Because of these findings, researchers suggested that patients with lower health literacy rates had a higher risk for hospitalization and used more medical services than the average population. The link between health and health literacy were understandably intertwined. However, the research to associate and link health literacy rates to other aspects of society were still forming.

While explicit links of health literacy to student achievement would even require more time, education became one of the first social domains linked to health literacy rates outside of economic effect. Low health literacy rates were linked to populations with high school education or less, learning disabilities, and lower reading levels (Nielsen-Bohlman et al., 2004). Understanding the effect of education on health literacy might also lead one to argue the inverse that parental health literacy could influence educational achievement. Researchers were now able to use these findings to further research student outcomes associated with health literacy.

The Arkansas Department of Health published a report in 2013, outlining the significant health problems faced by the state's population. In the report, the agency claimed that the state's population would soon face a growing shortage of primary medical, dental, and mental health workers while experiencing an increase in chronic disease (Arkansas Department of Health, 2013). In the action plan to combat the issues faced in healthcare throughout the state, the Arkansas Department of Health (2013) promoted health literacy as one of the top priority actions to implement across all 75 counties in the state. The same report indicated that 24% of the state's population were children under the age of 18. Of those 18 and younger, 27% lived in poverty. While no research existed indicating how many of these children had low health literacy rates existed, the report did indicate that 37% of the overall population was Below or Below-Basic in regards to health literacy rates (Arkansas Department of Health, 2013). Since Berkman et al. (2011) had already linked a parent's health literacy and its effect on children, Arkansas' students appear to be at a much higher risk for adverse events related to low health literacy than the national average. These events are not only health-related. The social ramification of nearly 40% of a state's population with low health literacy and the costs associated with such can be profound.

Effect on Student Achievement

Though no explicit links in research between health literacy and student achievement were found, new research has indicated some association between low health literacy rates and student achievement. Daigle, Herbert, and Humphries (2007) published a study linking health literacy to behavior in children aged 6-10. Children who demonstrated an understanding of health literacy showed positive developmental differences compared to their peers in regards to grasping abstract qualities (Daigle et al., 2007). Students who could understand and communicate their health also could think more abstractly than those who had low health literacy skills. The results indicated that physical health literacy might be a promising way to elicit behavioral changes in physical fitness and channel academic success (Gu, Zhang, Lun, Zhang, & Thomas, 2019). The exercise, conducted in Texas among 330 adolescents, indicated that physical health literacy variables were significantly related to an executive function or self-regulation skills (Gu et al., 2019). Paakkari et al. (2019) surveyed nearly 4,000 students aged 13-15 in the spring of 2014. The results indicated that student achievement and educational aspirations were among the factors that explained specific health indicators. In effect, students who had a lower achievement or who did not plan to continue an academic path had tended to have lower overall health than their peers with higher achievement or plans to continue an academic path. Though new research has not indicated direct links to health literacy as a predictive effect on student achievement, the idea that of such should not go unhypothesized.

Highly Mobile Students

For school districts trying to combat the effects of highly mobile statuses in academics and persistence, data collection is usually the first action to take place. The increasing phenomenon of highly mobile students can change up to 100% of the school's population in an inner-city setting (Jackson & Schuler, 1990). Schools with 20% or higher student mobility are considered highly mobile schools (Rhodes, 2005). In these cases, public schools are left to combat the issues of changing populations alone. Cleveland Public Schools (1989) was one of the first to publish data collected from a student mobility project. Minneapolis Public Schools used data from the self-created Kids Mobility Study to respond to changes in the school's population by implementing aggressive attendance goals over 3 years (Hinz, Kapp, & Snapp, 2003). When entire school campus populations change drastically, how schools respond to their populations also changes. Such measures are a combination of professionals across all the academia working together to collect data, interpret results, and discuss implications of student mobility and the associated effects in the public schools.

Student performance and persistence effects from high student mobility are not exclusive to urban school districts. This concept is supported by research conducted across the United States. Ohio Mobility Research Project directors, Ryan, Partin, and Churchill (2012), argued that highly mobile student issues could be found in schools from any geographic area, urban, suburban, or rural. The authors, in conjunction with the Fordham Institute, acknowledged the work was mostly descriptive and only lightly reviewed the causes and consequences of what they termed student nomads (Ryan et al., 2012). The changing dynamics and performance effects of student mobility are studied throughout academia.

Independent Versus Compounding Factor

When reviewing the literature on student mobility, covariates are often found among the predictors. According to Sewell (1982), covariates associated with highly mobile students often include poverty, limited English proficiency, and family dynamics. Students facing these hardships tend to fall higher on a continuum of risks than others, regardless of mobility (Masten, Fiat, Labella, & Strack, 2015). Sewell (1982) argued that children living with one parent move twice as frequently as children living with two parents and had lower overall academic achievement levels. Cleveland Public Schools published similar data in 1989 and examined the mobility of all students using the categories of attendance, tardiness, withdrawals, dropouts, and promotions. The results indicated increased family income correlated to increased attendance rates as well as increased student achievement scores in mathematics and reading (Cleveland Public Schools, 1989). Masten et al. (2015) claimed that children in homelessness faced far more significant adversity than other students of mobility. Regardless of mobility status, certain predictor variables tend to place students at significant disadvantages from their peers. Understanding student mobility as a compounding factor might lead one to consider the disadvantages as entirely separate variables. However, the literature on student mobility is usually generated from two patterns of thinking.

While some researchers view student mobility as a compounding factor, others view student mobility as an independent factor. Schafft (2005) conducted a study using data from rural, upstate New York and indicated that highly mobile students were at an increased risk for academic and social issues. The idea that student mobility independently influences phenomena is not a new concept. Scherrer (2013) attempted to determine whether student mobility was an actual mediator or a predictor of student reading achievement. After his two analyses were completed, he suggested student mobility was a predictor of an academic struggle for both students and schools (Scherrer, 2013). If student mobility is studied as an independent factor without using covariates, the implications can be much different. However, if student mobility can independently predict academic struggle as indicated in previous studies, educational leaders could effectively use data within their systems to determine how best to navigate academic effects arising from highly mobile student populations.

Significance and Effects

Most researchers are very clear on the effects of high student mobility on student performance. Student mobility has consistently been negatively associated with student performance and persistence data (Isernhagen & Bulkin, 2011; Masten et al., 2015; Rhodes, 2005; Schafft, 2005; Tanner-McBrien, 2010). Tanner-McBrien (2010) conducted 11 one-way ANOVAs to analyze student mobility variables on academic performance as recorded on California Standard Test scores. Results indicated that students with higher mobility achieved lower scores than peers with less mobility (Tanner-McBrien, 2010). Isernhagen and Bulkin (2011) published similar results from Nebraska. A mixed-method study with data from Nebraskan schools in 2007-2009 indicated highly mobile students scored lower on criterion-referenced exams than their non-highly mobile peers (Isernhagen & Bulkin, 2011). Since researchers agree that high student mobility yields adverse effects on student success, school leaders and researchers can begin conversations regarding policy and practice. Across the nation, from schools in urban, rural, and suburban settings, students with high mobility are not only at increased risks for academic achievement disadvantages, but they also perform lower and graduate at lower rates than their non-mobile peers.

In addition to the effects of high mobility on students' performance and persistence rates, school leaders also face the effects on accountability scores. Rhodes (2005) was the first to link the effects of student mobility, among other factors, to specific state and federal No Child Left Behind student performance requirements to which all public schools in the United States were once held accountable. Eigenvalues and a Wilks-Lambda measurement were produced to determine what role four variables played in school accountability scores. These variables included student mobility, school size, a student's socioeconomic status, and a student's ethnicity. Within the first function of the Wilks-Lambda measurement, mobility was the most influential factor of all variables. These values and analyses indicated that student mobility had a more substantial influence on a school's rating than the other three variables (Rhodes, 2005). Out of all the other factors tested, student mobility had the most significant effect on an individual school's accountability rating. Moreover, while no studies have been published linking student mobility to the new state and federal ESSA requirements, the link between student mobility and accountability scores can still be used to guide meaningful conversations today.

Summary

In recent years, chaos theory has evolved from being used to predict scientific phenomena associated with weather to being used as a teaching explanation to help decision-makers in social science fields understand complex systems, such as education. Lorenzen (2008) claimed that because education is connected to the rest of the universe, education, then, must be fully subject to the chaos that surrounds the world. For this study, the factors that are considered as chaos include school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rate by school. Understanding the various systems of chaos and their predictive effects on certain phenomena such as persistence rates, achievement scores, and accountability scores, school leaders and policymakers become much more prepared to interpret data and develop processes for moving forward in the 21st century. In Chapter III, I described the methods of the study in detail.

CHAPTER III

METHODOLOGY

As established in the review of the literature, scientists and mathematicians have used chaos theory, or the founding principles, for centuries to help explain, predict, and prepare for natural phenomena. In the same manner, educational leaders have been tasked to prepare for chaos while accepting the uncertainty of outcomes as an innate condition (Lorenzen, 2008). Researchers now possess the keen ability to scientifically predetermine a set of predicted results for any phenomenon in question based on potential influences. For this study, the possible influences on phenomena (4-year graduation rates of schools, ESSA building level scores of schools, and the average junior ACT composite score of schools) are school size, teacher absenteeism, pupil-teacher ratio, health literacy percentage, and highly mobile student rate by school.

School size was examined for its effects on certain outcomes, such as student persistence rates and student performance (Barrow et al., 2015). These results indicated that students attending smaller high schools tended to persist in school longer. However, the same study also determined that no positive effect existed in regards to student performance as measured by average scores on the ACT exam.

The topic of teacher absenteeism has been debated mainly in political arenas across the United States in recent years. In a relatively short period, teacher absenteeism has gone from a seldom explored topic of research to an issue of important significance across the spectrums of academia and politics. Miller et al. (2007) published a longitudinal study from a single urban school district in the United States to explore this very topic. After adjusting for time-invariant differences among teachers in skill and motivation, the results of the study indicated a significant effect on student achievement (Miller et al., 2007). Miller et al. (2007) claimed for every 10 days a teacher is absent from the classroom, students' mathematics achievement rates drop 3.3% of a standard deviation.

Pupil-teacher ratio has also become a topic of interest among educational leaders and policymakers in recent decades. As described in the review of literature, a meta-analysis of 85 published studies on the effects of pupil-teacher ratio on elementary and secondary students was conducted in the 1950s (Blake, 1954). From these 85 studies, 35 indicated that smaller class sizes had a positive effect on student achievement. However, 32 of these studies could not support any directional hypothesis. Since this study, results of numerous other studies have indicated mixed outcomes for effects on student achievement (Filges et al., 2018; Finn et al., 2001; Finn et al., 2005; Greene, 2005; Hanushek, 1999; Nye & Hedges, 2001; Wyss et al., 2007).

In 2003, the National Assessment of Adult Literacy indicated that up to 36% of the adult population in the United States had a Basic or Below-Basic health literacy level (Vernon et al., 2007). The Arkansas Department of Health (2013) published a report indicating that 37% of the overall population in Arkansas was Below or Below-Basic in regards to health literacy rates. Though no direct effects of health literacy on student achievement could be found in the review of literature, Daigle et al. (2007) were among the first to link health literacy to behavior in children aged 6-10, leading the way for expanded studies on children and school-based outcomes.

As noted in the review of literature, the increasing phenomenon of highly mobile students can change up to 100% of the school's population in an inner-city setting (Jackson & Schuler, 1990). In these cases, public schools are left to combat the issues of changing populations alone. Most researchers are clear on the effects of high student mobility on student performance. Student mobility has consistently been negatively associated with student performance and persistence data (Cleveland Public Schools, 1989; Hinz et al., 2003; Isernhagen & Bulkin, 2011; Masten et al., 2015; Rhodes, 2005; Schafft, 2005; Tanner-McBrien, 2010). Though initially conducted in an urban school environment, the negative effects of highly mobile student rates on student persistence rates and student performance are supported by research conducted across the United States (Ryan et al., 2012). Ryan et al. (2012) argued that highly mobile student issues could be found in schools from any geographic area, urban, suburban, or rural.

Therefore, I generated the following null hypotheses:

1. $H_0 1$: No significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on persistence as measured by the 4-year graduation rate for high schools in Arkansas.
2. $H_0 2$: No significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on accountability ratings as measured by the ESSA building score for high schools in Arkansas.

3. H_03: No significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas.

The objectives of this chapter are to (a) explain the research design, (b) describe the subjects and explain the sampling process, (c) describe the instrumentation, (d) explain the data collection process (e) examine and justify the process of statistical analysis, and (f) describe any limitations of this study.

Research Design

A quantitative, multiple regression analysis was used in this study. The independent or predictive variables for Hypothesis 1 were school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates. The dependent or criterion variable for Hypothesis 1 was persistence measured by the 4-year graduation rate for high schools in Arkansas. The independent or predictive variables for Hypothesis 2 were school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates. The dependent or criterion variable for Hypothesis 2 was the accountability rating measured by the ESSA building level score for Arkansas high schools. The independent or predictive variables for Hypothesis 3 were school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates. The dependent or criterion variable for Hypothesis 3 was the overall academic achievement measured by the average ACT composite score of juniors for high schools in Arkansas.

Sample

The population for this study included existing data from Arkansas public high schools, excluding virtual schools and special multi-area schools for alternative learning or juvenile detention centers. A stratified random sampling was taken from Arkansas' public high school data sets for the 2018-2019 school year via a random sampling calculator in Microsoft Excel. Data from 75 schools were selected and stratified by size: 25 schools were 2A or below, 25 schools were 3A or 4A, and 25 schools were 5A and above. The stratification sizes were categorized in the 2018-2020 Classification Report by the Arkansas Athletic Association (2017). These particular population-sizes translated to the following October 1 school population counts from DESE (2020): 608-2,181 (5A-7A), 190-598 (3A-4A), and 18-189 (1A-2A). Also, the population was stratified by geographic location throughout the state of Arkansas: 15 schools from each of the five regions (Central, Northwest, Northeast, Southwest, and Southeast). Each of the geographic regions contributed to 5 schools from each of the classification categories designed for this study. The Arkansas Association of Educator Administrators' (2020) School Spring website categorized the stratification regions. The random sampling of the 75 stratified Arkansas public high schools selected helped to ensure the populations of public high schools in the state were represented with equity. All criterion variable data were collected from the 2018-2019 school year via the official DESE (2020) My School Info public database.

Instrumentation

I constructed this study using five predictive variables on three specific criterion variables. The criterion variables used in this study were the 4-Year graduation rates, ESSA building level scores, and the average ACT composite scores of juniors for Arkansas high schools. Graduation rates are determined in 4-year and 5-year cohorts per the national ESSA legislation (Arkansas Department of Education, 2019). The 4-year graduation rate was calculated by taking the number of cohort members who earned a regular high school diploma by the end of the school year 4 years after the year the cohort was established and dividing the number by all members of the established cohort (Arkansas Department of Education, 2019). Then, the initial cohort was adjusted by the number of students who transferred in during the 4-year cohort timespan and the number of students who have transferred out to another public school, immigrated to another county, transferred to a prison or juvenile facility, or died during the 4-year cohort timespan (Arkansas Department of Education, 2019).

Arkansas ESSA building level scores were used to provide the building level score for each Arkansas high school from the sample. A school's ESSA score is calculated as follows: the weighted achievement and academic growth each at 35% of the overall score, the 4-year graduation rate at 10% and 5-year graduation rate at 5% of the overall score, and school quality and student success indicator (SQSS) at 15% of the overall score. The weighted achievement score is calculated by using a point system consisting of four achievement categories from English and mathematics achievement scores on the ACT Aspire (DESE, 2020). The weighted achievement score is calculated by summing the number of full academic year students at each achievement level (Levels

1-4) in English language arts (ELA) and mathematics to obtain the number of L1 (mathematics + ELA), number of L2 (mathematics + ELA), number of L3 (mathematics + ELA), and number of L4 (mathematics + ELA). Then, the sum of mathematics and ELA are compared between L1 students to the sum of mathematics and ELA L4 students to determine the number of L4 students multiplied by 1.00 and the number of L4 students multiplied by 1.25. Students scoring *In Need of Support* are awarded 0 points. Students scoring *Close* are awarded 0.5 points, and those scoring *Ready* are awarded 1.0 point. The fourth category is divided by awarded points. If the students scoring *Exceeds* is less than or equal to the number of students scoring *In Need of Support* for a particular school, students are awarded 1.0 point. If the students scoring *Exceeds* is greater than the number of students scoring *In Need of Support* for a particular school, students are awarded 1.25 points. Lastly, the sum of the points for all achievement levels is divided by the sum of the number of students at all achievement levels (Arkansas Department of Education, 2018).

The academic growth score is calculated by averaging the mathematics and ELA growth scores for each student based on the previous years' scores. If a student only tested in ELA or mathematics, that subject score will be the student's content growth score. Students will count only once for their content growth scores. If a student has a content growth score and an ELP growth score, the student will count twice in the overall school value-added growth calculation (Arkansas Department of Education, 2018). The 4- and 5-year graduation rates are calculated by dividing the total number of actual graduates within 4 and 5 years, respectively, from the time a student enters Grade 9 by the number of students in the initial cohort plus the number of on-time transfers into the cohort minus the number of on-time transfers out of the cohort (Arkansas Department of Education, 2018). The SQSS score is calculated by taking the number of students achieving the SQSS and dividing by the total number of students involved (usually by grade or overall number testing). The subcomponents of the SQSS score consisted of reading achievement on the ACT, science achievement on the ACT, science growth on the ACT from the previous year, on-time credits for each classification, high school GPA for seniors, ACT component, ACT readiness benchmark component consisting of a score of 22 or above on the ACT reading, AP/IB/Concurrent credit component, computer science credit component, and service-learning credit component. After each of the four major components of ESSA are calculated, each major component score is then multiplied by the determined multiplier and added together for an overall ESSA score for the school building (Arkansas Department of Education, 2018).

According to the Arkansas Department of Education (2019), the ACT has "long been recognized as one of the leading college entrance exams" (p. 9) and can be used to provide a longitudinal approach to education and career planning, a central component of the state's ESSA plan. The ACT testing instrument used in the state consists of four areas of testing: reading, English, mathematics, and science. The state of Arkansas does not require the writing subtest. ACT has a reliability score in reading of .87, English of .92, mathematics of .91, and science of .85, and an overall composite reliability score of .96 (ACT, 2019). The ACT exam consists of a total of 215 items in limited timed areas. The reading subtest consists of 40 questions with a 35 minutes limit, the English subtest consists of 75 questions with a 45-minute time limit, the mathematics subtest consists of 60 questions with a 60-minute time limit, and the science subtest consists of 40 questions with a 35-minute time limit. An average composite score of all juniors who tested during the state-administered ACT window in high schools is then calculated as an average ACT composite score for the school.

School Size calculations were categorized by the 2018-2020 Classification Report by the Arkansas Athletic Association (2017). These population sizes translated to the following October 1 school population counts from DESE (2020): 608-2,181 (5A-7A), 190-598 (3A-4A), and 18-189 (1A-2A). Coding was then attributed to two categories, Low (1A-3A) and High (4A-7A).

Health literacy percentages were categorized according to the National Assessment of Adult Literacy (Lurie et al., 2009). These scores from the National Assessment of Adult Literacy were then broken down into four categories: Below Basic (0-184), Basic (185-225), Intermediate (225-309), and Proficient (310-500) (University of North Carolina at Chapel Hill, 2014). For this study, SPSS coding attributed to this variable was as follows: 1 (Low Health Literacy) when less than 60% of the population scored at a 225 on the National Assessment of Adult Literacy and 2 (High Health Literacy) when 60.4% of the population or higher scored a 225 on the National Assessment of Adult Literacy (Lurie et al., 2009).

Data Collection Procedures

The data collection procedures began with the approval of the Institutional Review Board on February 18, 2020. Informed consent was not necessary because all data collections used in this study were publicly available from existing public databases. The databases being used to collect the data are from the Arkansas Department of Education's (2019) My School Info database, the Arkansas Department of Health (2013) data collection, and the United States Office for Civil Rights Database Collection (2020). All data were collected between April 1, 2020, and April 30, 2020. All information collected originated from the 2018-2019 school year, except for data on chronic teacher absenteeism (See explanations for any data issues in the Limitations section). Data collected electronically from websites were password protected and stored on my personal computer. Identities of participating school districts and assessment scores were kept confidential. Data were coded, and no personal or institutional identifications were used. Three years after the completion of this study, the data will be deleted. No risk should be involved for the participants.

Analytical Methods

Multiple regression was conducted using the IBM Statistical Package for the Social Sciences version 26.0.0.1 to address each of the three hypotheses. The random sampling calculation was conducted using Microsoft Office Excel version 16.16.7. For each analysis, school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates by school were entered as predictor variables against a specified criterion variable. The criterion variables of the three hypotheses were the 4-year graduation rate of Arkansas high schools, the ESSA building level score for Arkansas high schools, and the average ACT composite score of juniors for Arkansas high schools, respectively. As is common in educational and sociological studies, an alpha level of .05 was set for the two-tailed test of each null hypothesis.

Limitations

As is often a common occurrence in research, there were limitations to this study. The limitations of a study are those characteristics of methodology that influence the interpretation of results from research (Price & Murnan, 2004). According to Price and Murnan (2004), these characteristics become constraints on the generalizability, application to practice, and utility of the results created from the process researchers initially choose to design a study or the method used to establish validity. There may also be circumstances in which unanticipated challenges emerge during the study itself (Price & Murnan, 2004). For this study, limitations arose both from the method used to establish validity and unanticipated challenges.

The first limitation of this study was discovered when stratifying the public high schools in Arkansas to conduct a random sampling to choose participants. To stratify the schools by size and geographic region for validity purposes, the Southwest region of the state only contained four high schools in the 5A-7A category. To even this sampling stratification, a border school categorized as a Southeast region school of the next random sampling number from the random sampling calculator was used. This process balanced the geographic regions and school size categories from the 75 random sampling high schools without compromising the validity of the random sampling used in this research. Because this school was very close to other schools in the Southwest region and was randomly selected from the random sampling calculator in Microsoft Excel, no compromise to the research was found. Nevertheless, it was a limitation worth noting.

The following limitation to the study was discovered when I collected data from the United States Office for Civil Rights (2020) Database Collection. While all other data collected from databased in the study came from the 2018-2019 school year, the teacher absenteeism data published for this year was not yet available for public use. After writing the United States Office for Civil Rights Database Collection to inquire about a release date or permission to use the data, a response was given that the data would not be released until later in the fall of 2020, a timeline that was outside of the perimeters for this study. At this time, it was decided to use the latest data on chronic teacher absenteeism, which occurred in the 2015-2016 school year. Because teacher absenteeism data from this year would have had the possibility of influencing the outcomes of the 4-year graduation rate, the ESSA building level score, and the average ACT composite score of juniors for high schools in the 2018-2019 school, it was decided that this data would then be used to determine predictive effects on criterion variables. A future study using the 2018 data would be beneficial for future implications. For this study, the data were still valid and reliable.

The last limitation of the study arose in collecting data for the predictor variable for high mobile student population rates. As explained in the review of the literature, high mobile student population definitions are not standardized across the county. After emails and phone conversations with S. Green and L. Jenkins (personal communication, April 6-8, 2020) from the Office of Information Technology at DESE, I determined that because DESE had no data standardization of highly mobile students in the state, the data that aligned to the definition of high mobile student rates in this study had to first be established. For this study, a highly mobile student population rate was defined as the percentage of those students who lack a “fixed, regular and adequate nighttime residence” (DESE, 2020, para. 1). After this definition was established, data were collected of students who fit the highly mobile student terminology using the term *homeless,* including the encompassing term of *unaccompanied youth* (DESE, 2020). This data included youth "living in hotels, motels, camping grounds, cars, parks, abandoned buildings, sharing housing of others persons due to loss of housing in economic hardship, or similar settings due to lack of alternate adequate accommodations" for each individual high school (DESE, 2020, para. 3). While this definition may differ slightly from state to state or state to nation, the definition used in this study should overcome any limitations to the study.

Summary

After establishing the definitions, methodology, instrumentation, and procedures for data collection, I was confident that a multiple regression analysis was the most suitable analytical design for this study. This type of analysis gave me the principal advantage of predicting the influence of certain variables on the criterion variables used in the study. In Chapter IV, I outlined the results of the three hypotheses of the research and summarized the findings.

CHAPTER IV

RESULTS

This study explored the predictive effects of school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on three different criterion variables for high schools in Arkansas. For Hypotheses 1-3, the criterion variables were persistence as measure by the 4-year graduation rates, accountability ratings as measured by the ESSA building score, and overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas, respectively.

Sample data for this study comprised 75 Arkansas public high schools. I selected data from 75 schools and stratified them by size: 25 schools were 2A or below, 25 schools were 3A or 4A, and 25 schools were 5A and above (Arkansas Athletic Association, 2017). I stratified the sample by the five geographic locations throughout the state of Arkansas (Central, Northwest, Northeast, Southwest, and Southeast). Each of the geographic regions contributed five schools from each of the size classification categories designed for this study. The stratification regions were categorized by the Arkansas Association of Educator Administrators' (2020) School Spring website. I tested the null hypotheses using a two-tailed test with a .05 level of significance. The results of these analyses are discussed in this chapter.

Hypothesis 1

The first hypothesis stated that no significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on persistence as measured by the 4-year graduation rate for high schools in Arkansas. Before conducting a regression analysis, the data were examined to determine that assumptions for multiple regression were met. Looking at the residual plots, there appeared to be non-normal distribution, but several of the residuals showed the data were nearly all homoscedastic. An examination of the intercorrelation table indicated that two of the variables in the model, School Size and Pupil-Teacher Ratio (r = .662), had a strong correlation with each other. Because these two variables had a high correlation, R^2 was examined, resulting in a tolerance lower than 1 - R^2 (Leech, Barrett, & Morgan, 2015). Therefore, multicollinearity was considered problematic for the model. Furthermore, the choice was made to remove the variable of pupil-teacher ratio from the model. I then examined the data again to determine that assumptions for multiple regression were met. Looking at the residual plots, there appeared to be non-normal distribution, but several of the residuals showed the data were nearly all homoscedastic. An examination of the intercorrelation table indicated no variables in the new model had a strong correlation with each other, and no tolerance was lower than 1 - R^2. Therefore, multicollinearity was not a problem with the new model. Table 1 shows the means, standard deviations, and intercorrelations for 4-year graduation rate.

Table 1

Means, Standard Deviations, and Intercorrelations for 4-year Graduation Rate

Variable	*M*	*SD*	1	2	3	4
4-Yr grad rate	88.13	8.34	-.175	-.058	.011	.033
Pred Var						
1. Sch Size	1.52	0.50	1.000	.054	-.087	-.111
2. Teach Abs	31.38	19.63	.054	1.000	-.029	.079
3. Health Lit	1.68	0.47	-.087	-.029	1.000	.111
4. High Mob	3.01	4.10	-.111	.079	.111	1.000

Note. 4-Yr grad rate = 4-Year graduation rate; Pred Var = Predictor Variable; Sch Size = School Size; Teach Abs = Teacher Absenteeism; Health Lit = Health Literacy; High Mob = Highly Mobile. $N = 75$, except Teacher Absenteeism $N = 73$.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Finally, to test the assumptions of normally distributed residuals as well as homoscedasticity of residuals, a residual plot was generated. An examination of this plot did not reveal violations of homoscedasticity but did reveal violations of normal distribution. Because the regression model is robust, the test was still considered valid. To examine the fit of the regression model for predicting 4-year graduation rates, casewise diagnostics, as well as Cook's Distance test for influential cases, were conducted. These diagnostics revealed one significant outlier (Case Number 26), but no cases were identified as exerting significant influence in the model from Cook's Distance test. After testing all the relevant assumptions and model fit diagnostics, a standard multiple regression analysis was then conducted to determine the degree to which school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rate predicted the 4-year graduation rate for Arkansas high schools (see Table 2).

Table 2

Simultaneous Multiple Regression Analysis for Predicting 4-year Graduation Rate

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	166.29	4	41.57	0.58	.676
Residual	4845.17	68	71.25		
Total	5011.46	72			

Regression results indicated that the overall model did not significantly predict the 4-year graduation rate for Arkansas high schools, $R^2 = .033$, $R^2_{adj} = -.024$, $F(4, 67) = 0.58$, $p = .676$. These results did not indicate that this model was a better predictor of 4-year graduation rates for Arkansas high schools when compared to the grand mean, and hence the null hypothesis could not be rejected. The model accounted for approximately 3.30% of the variance in 4-year graduation rates for Arkansas high schools. A summary of the unstandardized and standardized regression coefficients for this model is presented in Table 3 and indicated that none of the four predictor variables significantly contributed to the model.

Table 3

Unstandardized and Standardized Coefficients for Predictors of 4-year Graduation Rate

Model	*B*	*SE*	*β*	*t*	*p*	Collinearity Statistics	
1(Constant)	93.20	5.23		17.82	.000	Tolerance	VIF
School Size	-2.83	2.00	-.17	-1.41	.162	.978	1.022
Teacher Absenteeism	-0.02	0.05	-.05	-0.42	.677	.989	1.011
Health Literacy	-0.13	2.14	-.01	-0.06	.951	.981	1.019
Highly Mobile	0.04	0.25	.02	0.16	.874	.970	1.031

Of the four predictor variables, all four were outside the significance level. School Size contributed the least (β = -.17) to 4-year graduation rates for Arkansas high schools. Similarly, results from the coefficient table revealed the equation for predicting 4-year graduation rates as follows: 4-year graduation rate (predicted) = 93.20 – (2.83)(School Size) – (0.02)(Teacher Absenteeism) – (0.13)(Health Literacy) + (0.04)(Highly Mobile).

Hypothesis 2

The second hypothesis stated that no significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on accountability ratings as measured by the ESSA building score for high schools in Arkansas. Before conducting a regression analysis, the data were examined to determine that assumptions for multiple regression were met. Looking at the residual plots, there appears to be normal distribution, and several of the residuals showed the data were nearly all homoscedastic.

An examination of the intercorrelation table indicated that two of the variables in the model, School Size and Pupil-Teacher Ratio (r = .662), had a strong correlation with each other. Because these two variables had a high correlation, R^2 was examined, resulting in a tolerance lower than 1 - R^2 (Leech et al., 2015). Therefore, multicollinearity was considered problematic for the model. Furthermore, the choice was made to remove the variable of pupil-teacher ratio from the model. The data were then examined again to determine that assumptions for multiple regression were met. Looking at the residual plots, there appeared to be non-normal distribution, but several of the residuals showed the data were nearly all homoscedastic. An examination of the intercorrelation table indicated no variables in the new model had a strong correlation with each other, and no tolerance was lower than 1 - R^2. Therefore, multicollinearity was not considered a problem with the new model. Table 4 shows the means, standard deviations, and intercorrelations for ESSA building scores.

Table 4

Means, Standard Deviations, and Intercorrelations for ESSA Building Scores

Variable	*M*	*SD*	1	2	3	4
ESSA Score	64.92	6.81	-.155	.050	.281**	-.029
Pred Var						
1. Sch Size	1.52	0.50	1.000	.054	-.087	-.111
2. Teach Abs	31.38	19.63	.054	1.000	-.029	.079
3. Health Lit	3.01	4.10	-.087	-.029	1.000	.111
4. High Mob	64.92	6.81	-.111	.079	.111	1.000

Note. ESSA Score = ESSA Building Score; Pred Var = Predictor Variable; Sch Size = School Size; Teach Abs = Teacher Absenteeism; Health Lit = Health Literacy; High Mob = Highly Mobile. $N = 75$, except Teacher Absenteeism $N = 73$.
$*p < .05$. $**p < .01$. $***p < .001$.

Finally, to test the assumptions of normally distributed residuals as well as homoscedasticity of residuals, a residual plot was generated. An examination of this plot did not reveal violations of homoscedasticity but did reveal violations of normal distribution. Because the regression model is robust, the test was still considered valid. To examine the fit of the regression model for predicting ESSA build level scores, casewise diagnostics, as well as Cook's Distance test for influential cases, were conducted. These diagnostics revealed no significant outlier in the model. After testing all the relevant assumptions and model fit diagnostics, a standard multiple regression analysis was then conducted to determine the degree to which school size, teacher absenteeism, district health literacy percentage, and highly mobile student population rate predicted the ESSA building level score for Arkansas high schools (See Table 5).

Table 5

Simultaneous Multiple Regression Analysis for Predicting ESSA Building Scores

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	357.38	4	89.35	2.04	.099
Residual	2980.31	68	43.83		
Total	3337.69	72			

Regression results indicated that the overall model did not significantly predict the ESSA building scores for Arkansas high schools, $R^2 = .107$, $R^2_{adj} = .055$, $F(4, 68) = 2.04$, $p = .099$. These results did not indicate that this model was a better predictor of ESSA building scores for Arkansas high schools when compared to the grand mean, and hence the null hypothesis could not be rejected. The model accounted for approximately 10.70% of the variance in ESSA building scores for Arkansas high schools. A summary of the unstandardized and standardized regression coefficients for this model is presented in Table 6 and indicated that one of the four predictor variables (Health Literacy) significantly contributed to the model.

Table 6

Unstandardized and Standardized Coefficients for Predictors of ESSA Building Scores

Model	*B*	*SE*	*β*	*t*	*p*	Collinearity Statistics	
1(Constant)	60.67	4.10		14.79	.000	Tolerance	VIF
School Size	-1.94	1.57	-.14	-1.24	.220	.978	1.022
Teacher Absenteeism	0.03	0.04	.07	0.63	.531	.989	1.011
Health Literacy	4.06	1.68	.28	2.42	.018	.981	1.019
Highly Mobile	-0.14	0.19	-.08	-0.70	.487	.970	1.031

Of the four predictor variables, Health Literacy contributed to the model the most ($\beta = .28$), and Chronic Teacher Absenteeism contributed the least ($\beta = .07$) to ESSA building scores for Arkansas high schools. Similarly, results from the coefficient table revealed the equation for predicting ESSA building level scores as follows: ESSA Building Score (predicted) = 60.67 – (1.94)(School Size) + (0.03)(Teacher Absenteeism) + (4.06)(Health Literacy) – (0.14)(Highly Mobile).

Hypothesis 3

The third hypothesis stated that no significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas. Before conducting a regression analysis, the data were examined to determine that assumptions for multiple regression were met. Looking at the residual plots, there appears to be normal distribution, and several of the residuals showed the data were nearly all homoscedastic. An examination of the intercorrelation table indicated that two of the variables in the model, School Size and Pupil-Teacher Ratio (r = .662), had a strong correlation with each other. Because these two variables had a high correlation, R^2 was examined, resulting in a tolerance lower than 1 - R^2 (Leech et al., 2015). Therefore, multicollinearity was considered problematic for the model. Furthermore, the choice was made to remove the variable of pupil-teacher ratio from the model. The data were then examined again to determine that assumptions for multiple regression were met. Looking at the residual plots, there appeared to be non-normal distribution, but several of the residuals showed the data were nearly all homoscedastic. An examination of the intercorrelation table indicated no variables in the new model had a strong correlation with each other, and no tolerance was lower than 1 - R^2. Therefore, multicollinearity was not a problem with the new model. Table 7 shows the means, standard deviations, and intercorrelations for average ACT composite scores.

Table 7

Means, Standard Deviations, and Intercorrelations for Average ACT Composite Scores

Variable	*M*	*SD*	1	2	3	4
Ave ACT	18.91	2.01	.111	.095	.309**	-.110
Pred Var						
1. Sch Size	1.52	0.50	1.000	.054	-.087	-.111
2. Teach Abs	31.38	19.63	.054	1.000	-.029	.079
3. Health Lit	1.68	0.47	-.087	-.029	1.000	.111
4. High Mob	3.01	4.10	-.111	.079	.111	1.000

Note. Ave ACT = Average ACT Composite Scores; Pred Var = Predictor Variable; Sch Size = School Size; Teach Abs = Teacher Absenteeism; Health Lit = Health Literacy; High Mob = Highly Mobile. $N = 75$, except Teacher Absenteeism $N = 73$.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Finally, to test the assumptions of normally distributed residuals as well as homoscedasticity of residuals, a residual plot was generated. An examination of this plot did not reveal violations of homoscedasticity but did reveal violations of normal distribution. Because the regression model is robust, the test was still considered valid. To examine the fit of the regression model for predicting average ACT composite scores, casewise diagnostics, as well as Cook's Distance test for influential cases, were conducted. These diagnostics revealed no significant outlier in the model. After testing all the relevant assumptions and model fit diagnostics, a standard multiple regression analysis was then conducted to determine the degree to which school size, teacher absenteeism, district health literacy percentage, and highly mobile student population rate predicted the average ACT composite scores for high school juniors in Arkansas high schools (See Table 8).

Table 8

Simultaneous Multiple Regression Analysis for Predicting Average ACT Composite Scores

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	42.05	4	10.51	2.86	.030
Residual	250.11	68	3.68		
Total	292.16	72			

Regression results indicated that the overall model did not significantly predict the ACT composite scores for juniors in Arkansas high schools, $R^2 = .144$, $R^2_{adj} = .094$, $F(4, 68) = 2.86$, $p = .030$. These results indicated that this model was a better predictor of average ACT composite scores for juniors in Arkansas high schools when compared to the grand mean, and hence the null hypothesis was rejected. The model accounted for approximately 14.40% of the variance in average ACT composite scores. A summary of the unstandardized and standardized regression coefficients for this model is presented in Table 9. One of the four predictor variables (Health Literacy) significantly contributed to the model. The results indicated that as students move from low Health Literacy to high Health Literacy, the predicted increase in the average ACT composite scores would be 1.45, assuming all other predictors were held constant.

Table 9

Unstandardized and Standardized Coefficients for Predictors of Average ACT Composite Scores

Model	*B*	*SE*	*β*	*t*	*p*	Collinearity Statistics	
1(Constant)	15.61	1.19		13.14	.000	Tolerance	VIF
School Size	0.47	0.45	.12	1.04	.301	.978	1.022
Teacher Absenteeism	0.01	0.01	.11	0.97	.335	.989	1.011
Health Literacy	1.45	0.49	.34	2.99	.004	.981	1.019
Highly Mobile	-0.07	0.06	-.14	-1.26	.212	.970	1.031

Of the four predictor variables, Health Literacy contributed to the model the most ($\beta = .34$), and Chronic Teacher Absenteeism contributed the least ($\beta = .11$) to average ACT composite scores for juniors in Arkansas high schools. Similarly, results from the coefficient table revealed the equation for predicting average ACT composite scores as follows: Average ACT Composite (predicted) = 15.61 + (0.47)(School Size) + (0.01)(Teacher Absenteeism) + (1.45)(Health Literacy) – (0.07)(Highly Mobile).

Summary

The results of the multiple linear regression analyses indicated that the combination of school size, teacher absenteeism, health literacy, and highly mobile percentage had no predictive effect on 4-year graduation rate and ESSA building scores for high schools in Arkansas. However, those same four predictors did significantly predict average ACT composite scores for juniors in Arkansas high schools. The summary of results is displayed in Table 10.

Table 10

Summary of p Values for the Model with School Size, Teacher Absenteeism, Health Literacy, and Highly Mobile on 4-Year Graduation Rate, ESSA Building Scores, and Average ACT Composite Scores

Variables by H_o	H1	H2	H3
Model	.676	.099	.030
School Size	.162	.220	.301
Teacher Absenteeism	.677	.531	.335
Health Literacy	.951	.018	.004
Highly Mobile	.874	.487	.212

Of the four predictor variables, Health Literacy was the only single predictor that contributed significantly to the models in Hypotheses 2 and 3. In Hypothesis 3, the model accounted for approximately 14.40% of the variance in average ACT composite scores. Chapter V contains a discussion of the results and will include the findings, the implications, and the recommendations.

CHAPTER V

DISCUSSION

There were three purposes to this study, centered on the theoretical framework of chaos theory. I sought to use chaos theory to determine predictive effects of certain factors upon predetermined phenomena such as retention rates, accountability scores, and average achievement scores for high schools in the state of Arkansas. First, I conducted a multiple regression analysis to determine the predictive effects of school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on persistence as measured by the 4-year graduation rates for high schools in Arkansas. Second, I conducted a multiple regression analysis to determine the predictive effects of school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on accountability ratings as measured by the ESSA building score for high schools in Arkansas. Third, I conducted a multiple regression analysis to determine the predictive effects of school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas. Chapter V translates the findings of the statistical analyses into reliable conclusions, seeks to understand and interpret the implications of the results from the study, and finally leaves the reader with actionable recommendations for moving forward in policy, practice, and future research.

Findings and Implications

A quantitative, multiple regression was used in this study. The 4-year graduation rate, ESSA building level score, and average junior ACT composite scores were collected from 75 randomly selected public high schools in the state of Arkansas after being stratified by school size and geographic location. The independent or predictor variables were the same for each criterion variables: school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile population rate. Each analysis examined the significance of each model. Then, each predictive variable was considered within the models to determine the extent the predictive variables contributed to the overall prediction of phenomena.

Hypothesis 1

Hypothesis 1 stated that no significant predictive effects will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on persistence as measured by the 4-year graduation rate for high schools in Arkansas. Before conducting a regression analysis, the data were examined to determine that assumptions for multiple regression were met. An examination of the intercorrelation table indicated that School Size and Pupil-Teacher Ratio had a strong correlation with each other (Leech et al., 2015). Because these two variables had a high correlation, multicollinearity was considered problematic for the model, and the choice was made to remove the variable of pupil-teacher ratio from the model. The data were then examined again to determine that assumptions for multiple regression were met in the new model. A standard multiple regression was then conducted to determine the extent to which school size, teacher absenteeism, district health literacy percentage, and highly mobile student population rates predicted persistence as measured by the 4-year graduation rate for high schools in Arkansas. Regression results indicated that the overall model did not significantly predict the 4-year graduation rate for Arkansas high schools. Therefore, the null hypothesis for the model could not be rejected. The model accounted for approximately 3.3% of the variance in 4-year graduation rates for Arkansas high schools. A summary of the coefficients indicated that none of the predictor variables significantly contributed to the model.

Hypothesis 2

Hypothesis 2 stated that no significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates as measured on accountability ratings as measured by the ESSA building score for high schools in Arkansas. Before conducting a regression analysis, the data were examined to determine that assumptions for multiple regression were met. An examination of the intercorrelation table indicated that School Size and Pupil-Teacher Ratio had a strong correlation with each other (Leech et al., 2015). Because these two variables had a high correlation, multicollinearity was considered problematic for the model, and the choice was made to remove the variable of pupil-teacher ratio from the model. The data were then examined again to determine that assumptions for multiple regression were met in the new model. A standard multiple regression was then conducted to determine the extent to which school size, teacher absenteeism, district health literacy percentage, and highly mobile student population rates predicted accountability ratings as measured by the ESSA building score for high schools in Arkansas. Regression results indicated that the overall model was slightly outside the significance level and, therefore, did not significantly predict the ESSA building score for Arkansas high schools. Thus, the null hypothesis for the model could not be rejected. The model accounted for approximately 10.7% of the variance in ESSA building score for Arkansas high schools. A summary of the coefficients indicated that only health literacy percentages contributed significantly to the model.

Hypothesis 3

Hypothesis 3 stated that no significant predictive effect will exist between school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas. Before conducting a regression analysis, the data were examined to determine that assumptions for multiple regression were met. An examination of the intercorrelation table indicated that School Size and Pupil-Teacher Ratio had a strong correlation with each other (Leech et al., 2015). Because these two variables had a high correlation, multicollinearity was problematic for the model, and the choice was made to remove the variable of pupil-teacher ratio from the model. The data were then examined again to determine that assumptions for multiple regression were met for the new model. A standard multiple regression was then conducted to determine the extent to which school size, teacher absenteeism, district health literacy percentage, and highly mobile student population rates predicted the ACT composite score of juniors for high schools in Arkansas. Regression results indicated that the overall model did significantly predict the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas. Therefore, the null hypothesis for the model could be rejected. The model accounted for approximately 14.4% of the variance in the ACT composite score of juniors for high schools in Arkansas. A summary of the coefficients indicated that only health literacy percentage contributed significantly to the model.

The results of this study were mixed. The same set of 5 predictor variables were calculated to determine if any effects existed on three specific criterion variables. The results of this study were used to explain whether certain variables associated with schools and students could be used to predict a school's retention rate, accountability, and average overall achievement. The analyses conducted in this study produced six items to be considered for implication. The following is a synthesis between the results of this study and the review of related literature.

First, the results of this study indicated that school size did not significantly contribute to the models predicting school retention, accountability, or achievement. The findings in this study also indicated that school size alone was not a significant predictor of school retention rates, accountability scores, or overall achievement scores. Howley et al. (2000) noted the idea that school size could not stand alone as a predictor variable and was often conducted as a covariate of poverty. However, these findings conflicted with Howley's (1994) early work that asserted smaller school sizes would positively influence outcomes such as achievement and attendance. Raywid (1999) claimed that an emphasis on community values might be critical in the school size debate. Since Arkansas has more rural community values compared to more populous states, the findings in this study align more with Raywid's (1999) claim. In Arkansas, while school size is relatively smaller in comparison to other states, this study should not be used to further the debate of any one side. Instead, the findings of this study should indicate that school size alone cannot be used as a predictor variable of specific school-based outcomes.

Second, the results of this study indicated that teacher absenteeism did not significantly contribute to the models predicting school retention, accountability, or achievement. The findings in this study also indicated that teacher absenteeism alone was not a significant predictor of school retention rates, accountability scores, or overall achievement scores. Miller et al. (2007) were the first to link chronic teacher absenteeism to lower student achievement. Thus, Miller et al. implied that achievement scores in schools could be predicted by chronic teacher absenteeism reliably. Although they found that teacher absenteeism was linked to a 3.3% standard deviation drop-in mathematics achievement rates on students, the same could not be said for the overall average achievement of the ACT. In addition, the work of Griffin (2017) and Porres (2006) focused on student achievement and the cost of chronic teacher absenteeism, not a single achievement test like the ACT. The lack of significance from teacher absenteeism on certain school-based outcomes has the potential to skew the arguments of educational leaders if it is not discussed within the context of this study. Individual student achievement scores, gaps in special populations, and other achievement tests outside of the ACT were not explored.

Third, the results of this study indicated that pupil-teacher ratio was not only the least significant of predictor variables used in this study but was also the most problematic of all five predictor variables in all three regression models due to its issues of multicollinearity with school size. After issues of multicollinearity were discovered between school size and pupil-teacher ratio, pupil-teacher ratio was removed accordingly, leaving each of the regression models with four predictive variables. In addition to its multicollinearity, studies using pupil-teacher ratio as a predictor variable resulted in mixed findings (In-Soo & Chung, 2009; Nye et al., 2001). These results only further implicated the reliability of the work conducted by Blake (1954) and Hedges and Stock (1983). Though these results might come as a surprise to many educators in the classroom, they align well with the arguments Coleman (1971) made from his published work on the subject in the early 1970s. Because school size and pupil-teacher ratio tend to follow many of the same trends in the state of Arkansas, the data as separate variables could not be used with confidence in these regression analyses. In addition, pupil-teacher ratio alone should not be used to predict school retention rates, accountability, or overall average achievement.

Fourth, although the results of this study indicated that while health literacy did not significantly contribute to the model predicting school retention and accountability, health literacy did contribute substantially to the model predicting overall school achievement. The findings in this study also indicated that while health literacy alone was not a significant predictor of school retention rates, it was a significant predictor for school accountability scores and overall school achievement scores. Furthermore, the results indicated that as districts move from low health literacy to high health literacy, the predicted increase in the average junior ACT composite score for its high schools is 1.45, assuming all other predictors were held constant. This finding equates to a percentage increase of 4.02% in the overall junior ACT composite score for these high schools. According to DESE (2020), a mere 8.5 units separate the lowest average junior ACT composite score from the highest average junior ACT composite score in the sample. A 1.45 unit increase could have a significant effect on closing this achievement this gap.

Of the four predictor variables used in the updated regression models, only health literacy significantly affected school accountability as measured with the ESSA building level score for Arkansas high schools. Because research examining health literacy was limited, the implications of these findings on health literacy should be used to aid further research on school accountability and achievement scores. The results should also create an open dialogue between leaders and policymakers about school achievement and accountability, particularly for those schools that may be in counties with low health literacy rates. In addition, the results of this study should be used with previous research (Daigle et al., 2007; Gu et al., 2019; Paakkari et al., 2009) to aid future studies on health literacy and its effect on educational outcomes. Daigle et al. (2007) linked health literacy to behavioral issues in children aged 6-10. Next, Gu et al. (2019) connected the effects of health literacy on self-regulation skills among adolescents. Finally, Paakkari et al. (2009) indicated that student achievement and educational aspirations could be explained with specific health indicators. The implications of this study should expand health literacy's documented links to the educational environment.

Although dependent upon the unique population of public Arkansas high schools, the results of this study are applicable for educational leaders and policymakers alike, particularly in the specialized fields of school accountability, persistence rates, and student achievement. These findings are also relevant for those public institutions serving a higher population of students in low health literacy counties.

Fifth, the results of this study indicated that highly mobile student percentage rates did not significantly contribute to the models predicting school retention, accountability, or achievement. The findings in this study also indicated that highly mobile student percentage alone was not a significant predictor of school retention rates, accountability scores, or overall achievement scores. From the review of literature, Rhodes (2005) noted for schools to be considered highly mobile, at least 20% or more of their student body had to be identified as highly mobile. While three schools in the study came close to this threshold, none of the 75 schools randomly selected passed beyond the threshold. This knowledge could be used to argue why the results differed from previous studies (Isernhagen & Bulkin, 2011; Masten et al., 2015; Rhodes, 2005; Scherrer 2013; Tanner-McBrien, 2010). In addition, the research does not negate other student issues that may arise from increased high mobility student percentages such as limited English proficiency, higher poverty rates, and hardships in family dynamics (Masten et al., 2015; Ryan et al., 2012; Schafft, 2005). Also, while lofty attendance goals, as indicated from research conducted by Hinz et al. (2003), may be used to respond successfully and systemically to dramatic changes in schools with high student mobility rates, it may not be appropriate to do so in schools with much lower rates.

Lastly, in addition to the implications of the predictor variables used in this study, the use of chaos theory was a viable theoretical framework in which educational research could be explained. Like the theory's scientific counterpart, chaos theory was used to explain complex systems that often appear to behave randomly but work within an underlying structure of order (Smith, 2007). Because education is part of the universe in which people live, the system is, by default, subject to chaos theory in the same way the physical realms of sciences would be subject to chaos theory (Lorenzen, 2008). The results and process of this study further implicated the research from Smith (2007) and Lorenzen (2008) and the use of chaos theory for future educational research that is grounded in scientific and mathematical principles applied to the social processes associated with education to predict certain phenomena. Much like the work of Livingston et al. (1998), the chaos theory helped educators to understand the educational setting and how the predictor and criterion variables interrelated validly and reliably. As social scientists and educational leaders conduct future research in this field, chaos theory should become a universally accepted framework in which that research is conducted.

Recommendations

Potential for Practice/Policy

This study was conducted to determine if certain predictive variables influence the achievement of accountability goals, specifically 4-year graduation rates, the overall ESSA building score, and the average junior ACT composite score for high schools in the state of Arkansas. Since results from this study have indicated some variables do influence the achievement of state and federal accountability goals and criteria, ethical and political issues need to be addressed by policymakers and educational leaders. Policymakers and educational leaders should understand how specific predictive factors could affect the outcomes used to measure student achievement in the American educational system. This system is unique from many educational programs throughout the world and was created and molded to educate every child in the nation, regardless of physical, cognitive, or environmental factors that surround the child. Because of the educational system's uniqueness, state and federal accountability efforts should be designed with these aims in mind.

The results of this study indicated health literacy could affect ESSA building level scores. However, health literacy is not even a term that is part of the data collection process within the Arkansas Department of Education. Based on the results of this research, a recommendation to begin a formal collection of health literacy data among Arkansas schools could prove to be a beneficial practice. Having policies in place that start to prioritize these data would create opportunities for school and state leaders to implement the data in decision-making practices related to education in the state.

Moreover, a standardization of the term and data collection for highly mobile students should be implemented on a state or federal level. Once a standardized definition is determined, a reexamination of this research using data within the confines of the definition would be recommended. This reexamination could occur on a state or federal level.

On the other side of the spectrum, this research could be used to guide policymakers in determining how to use data currently collected to inform decisions within education. For example, this study indicated that chronic teacher absenteeism did not significantly affect school accountability scores, retention rates, or average school achievement scores. Policymakers need to examine the usefulness of continual collection of these data relating to these outcomes. School size and pupil-teacher ratio should also be reexamined when used to develop policies and practices associated with similar issues found in this research.

Accountability regulations have increased significantly over the past 50 years in American education. While these accountability regulations have been designed with similar intentions, many school leaders could still be at a disadvantage in achieving the goals of the state and federal government. Though accountability should never become a pejorative term for educational professionals, policymakers should reexamine the current achievement goals used for measurement in accountability and achievement efforts. Then, they should consider the plausibility of weighting the assessment of such goals based on research data that are reliable and valid. Furthermore, policymakers should reexamine the current achievement goals used in the accountability process to produce a more equitable accountability scale for schools across state and national levels. I hope that this research can contribute to such a re-examination.

Future Research Considerations

This study provided results of predictive effects on school retention rates, accountability, and average achievement scores within the population of public school in the state of Arkansas. Any limitations of the study should be further examined through additional data and research as they become available. In addition, to strengthen the body of research regarding the chosen predictive effects on school retention rates, accountability, and average achievement scores, I recommend further examination of the following:

1. Research should be conducted on a national level where pupil-teacher ratios might be less likely to contain issues of multicollinearity with school size data.

2. Research should be conducted on a national level where large school sizes are much more readily available for geographic stratification.
3. Research should be conducted using the same predictor variables as used in this study with updated data from the United States Department of Education's Office for Civil Rights Database Collection set to be released in late fall 2020.
4. Standardization of the term and data collection for highly mobile students should be implemented on a state or federal level.
5. Further research of predictive effects on educational outcomes using the framework of chaos theory should continue.
6. Further research should be conducted to determine if better evaluation measures other than the current accountability criterion found in the Arkansas ESSA plan exists.
7. Further research should be conducted to determine the extent to which school retention rates and average school achievement scores should be weighed for accountability purposes.
8. Additional data on health literacy should be collected by research and educational institutions and state and federal agencies.
9. Additional research on health literacy's predictive effects on student achievement and persistence rates should be conducted and applied to the field of education.
10. Additional research on health literacy's predictive effects on school accountability should be conducted and applied to the field of education.

11. Further research should be considered to determine the extent to which health literacy should be factored into the calculation of school accountability measures.
12. Causal relationships between the variables used in this study should be examined.

Conclusion

This study was conducted to determine the predictive effects of school size, teacher absenteeism, pupil-teacher ratio, district health literacy percentage, and highly mobile student population rates. These predictive factors were examined on persistence as measured by the 4-year graduation rates, on accountability ratings as measured by the ESSA building score, and on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas. Chapter V is an overview of the findings and implications for the three hypotheses. Of all four predictor variables examined in the models, Health Literacy was the only single predictor that contributed significantly to the models regarding the criterion variables of accountability ratings as measured by the ESSA building score and on the overall academic achievement as measured by the average ACT composite score of juniors for high schools in Arkansas. Using chaos theory as the framework, this research not only complemented existing literature but could be used as new literature and research to better understand health literacy and its predictive effects on certain school-based outcomes.

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