12-2-2010

# Science on the Back Burner? Exlploring Significant Differences in Test Scores

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# SCIENCE ON THE BACK BURNER?
# EXPLORING SIGNIFICANT DIFFERENCES IN TEST SCORES

by

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A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Education

Major: Instruction and Curriculum Leadership

The University of Memphis

December, 2010

Abstract

Harrington, Rhonda Hardin. Ed.D. The University of Memphis. December/2010. Science on the Back Burner? Exploring Significant Differences in Test Scores. Major Professor: Satomi I. Taylor, Ph.D.

This study was a retrospective study evaluating whether the implementation of Smart Start Legislation had an impact on Stanford Achievement tests and Arkansas state benchmark tests in science, math, and literacy scores for fifth-grade students in Arkansas. Smart Start focuses on strong accountability stressing well defined, high educational standards in math and reading. The purpose of this study was to examine if there was a significant difference in test scores of students affected by public policy mandates requiring a teaching focus on math and literacy. The specific research questions were, Is there a significant difference in math scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students? and, Is there a significant difference in literacy scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students? The Statistical Package for the Social Sciences (SPSS) for windows 17.0 was used to analyze the data to address the research questions. Preliminary analyses examined frequencies, distributions histograms, and box-plots to evaluate potential outliers. Two independent t- tests were run to determine any statistically significant differences in the changes of math and literacy scores on the Arkansas augmented benchmark comparing test scores across those students taking the benchmark prior to the implementation of Smart Start Legislation and those students taking the Arkansas augmented benchmark following the implementation of Smart Start Legislation. Effect sizes were also conducted to determine the magnitude of possible differences. Results indicated that there was a statistically significant difference between

1998 reading scores and 2009 reading scores. The percent of students who scored below the basic proficiency were significantly higher in 1998 than in 2009. In addition, there was a large effect size. Math scores also indicated that there was a statistically significant difference between the percent of students who scored below basic proficiency for math scores in 1998 and in 2009, and included a large effect size for math. The evidence of the differences in the changes in math and literacy scores supports the implementation of the Arkansas Smart Start Initiative, an early childhood program mandating a math and literacy focus.

## Dedication

I would like to dedicate this dissertation to my family.
Thank you for all of your support and
encouragement throughout this process.
Neal, I could not have done it without you!
Thank you for all of your support, Ben!

I would also like to dedicate this dissertation in memory of my son,
Adam Neal Harrington, who went to Heaven at 19 years of age.
We will see you again!

# Acknowledgements

I gratefully acknowledge the advice and support of my committee, who devoted time from their busy schedules to offer guidance, encouragement, and approval throughout the completion of my dissertation.

Chair: Satomi Taylor, Ph.D.

You were my first point of contact at the University of Memphis, and I appreciate your immediate acceptance of an advising role that really turned into a mentoring friendship. I have enjoyed the classes you taught and I am grateful for the opportunity I had to present with you at a conference. Thank you for all of the phone calls and encouragement! You have always challenged me to “dig deeper” and I am a better thinker and teacher because of that. I look forward to publishing with you again in the future!

Michelle Stockton, Ph.D.

You were the first instructor who made statistics comprehensible to me! I appreciate the way you teach what you teach. Your guidance was invaluable in detailing data requests for the state department! Thank you for the SPSS advice, phone calls, e-mails, and playing the waiting game with the data! I know we will be life-long friends!

Cathy Meredith, Ed.D.

Thank you for the positive reinforcement and warm, encouraging personality you have shared throughout this process. I remember sitting in your office discussing the possibility of a study involving science. You have been with me from the beginning of this dissertation to the end. You have always treated me as a professional and it has been a pleasure to work under your supervision. Thank you for serving on my committee!

Sally Blake, Ph.D.

Thank you for agreeing to serve on my committee based only on Dr. Taylor’s recommendation! From the first e-mail, you have been enthusiastic about my study. Your insight and comments encouraged me to think of science beyond the education perspective. I appreciate the time you have dedicated toward the completion of my dissertation!

The Late Wali Abdi, Ph.D.

Dr. Abdi was one of the most energetic, positive, and encouraging people I have ever met. He always provided enthusiastic support for his students. I know his presence has been sorely missed at the University of Memphis.

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# CHAPTER I

# INTRODUCTION

To prepare for multiple careers in an increasingly technologically complex society, students need to be scientifically literate, to be well-informed about current social and environmental issues, and to benefit from science knowledge. A high quality science education plays an important role in preparing people for a progressively more competitive global society (Moyer-Packenham, Kitsantas, Bolyard, Huie, & Irby, 2009). Rising from the Gathering Storm, a report (2007) from the National Academy of Sciences (NAS), notes the significance of improving K-12 science education as one of the most important methods for increasing America's talent pool. There is a concern that a weakening of science and technology in the United States would inexorably affect societal and economic conditions and specifically erode the capability of its population to compete for high-quality jobs (NAS, 2007). All learners, not only those who intend to pursue a career in science, should learn how scientific knowledge is created (McGinnis & Roberts-Harris, 2009).

Science is defined as "an area of knowledge created by people who explore some part of nature and try to make sense of it" (Koch, 2005, p.3). Koch (2005) further clarifies science as a process, a set of ideas encompassing familiar subject areas such as life science, physical science, and earth and space science, and a set of attitudes. Process refers to a series of actions or steps (Krajcik, Czerniak, & Berger, 2003). Science attitudes consist of an effort and desire to discover facts to support findings, a willingness to amend ideas when challenged with new evidence, and a willingness to cooperate and collaborate with others (Koch, 2005). Sherman and Sherman (2004) describe science as knowledge of nature and the pursuit of that knowledge. Charlesworth and Lind (2010) suggest that in order to gain scientific knowledge, students need to interact with materials, collect data, and make some order out of that information. Recent data (Blake, 2009) indicate, “the longer students stay in the U.S. school system, the worse they do on science assessments” (p. 53). Encouraging students to be successful learners who will contribute to society in the future begins with exposure to scientific concepts at the early childhood level, with multifaceted layers of these concepts added throughout the public school years, as children develop higher order processing skills. Students’ learning will be inhibited if they do not have a degree of relevant background knowledge (DuVall, 2001).

Science in the early childhood ages introduces children to the big picture of broad scientific concepts (Klein, Hammrich, Bloom, & Ragins, 2000). However, there is little meaningful science instruction at the elementary school level, and many teachers tend to focus on the definition of scientific terms, memorization of formulas, and recall of facts rather than provide opportunities for children to explore and make discoveries in a science rich environment (Abdi, Taylor, & Freilich, 1998; Chavez, 2002; Lederman, Lederman, & Bell, 2004). These teachers may not have the necessary training and confidence to teach integrated hands-on science. Teaching across content areas, usually around a topic of interest to the children, helps them to make connections between prior knowledge and new information they are learning (Diffily, 2003). Learning will become more meaningful to students when they know their ideas and interests are valued (Harrington & Taylor, 2006).

Quality science instruction at the elementary level is necessary for children to understand new science concepts and content as they move on to middle school and high school (Charlesworth & Lind, 2010; McGinnis & Roberts-Harris, 2009; New, 1998). Malcom (1999), from the American Association for the Advancement of Science, reports a growing realization that access to thoughtful engaging experiences in science, math, and technology throughout the early childhood years can provide both short-and long-term benefits to all children. The inherent curious nature of young children provides the foundation for science learning beginning with inquisitive preschoolers and continuing on to children in higher grades (Bosse, Jacobs, & Anderson, 2009). Science is important for young children because it matters to them (Malcom, 1999). Teachers must be conscious of their role in creating an appropriate science-supportive learning environment. The teacher's sense of excitement and enthusiasm about the learning process can encourage children (Howley-Pfeifer, 2002). Teacher attitudes toward teaching science affect planning and implementation of effective science instruction (Harrington & Taylor, 2006).

In the last several years, a strong emphasis on math and literacy test performance has caused many school districts to put science on the back burner, or greatly reduce time spent on science instruction. Science is a subject that has been pushed aside in order to increase student performance in the areas of math and reading (Williamson, Bondy, Langley, & Mayne, 2005). School districts are required to show how they are meeting identified goals in competency areas such as reading and math (Warner & Sower, 2005). Federal, state, and local policies have affected curriculum content and teaching methods (Morrison, 2009). Public laws and agency programs concerned with accountability have directed school districts to improve students' reading and math test scores, while time spent on science and other subjects has been shortened, and in some cases, eliminated from the instructional day (Vargas, 2008). A major issue with educational policies today is that a majority of the decision making process takes place in Congress and in boardrooms across the United States instead of the local schools (Perez & Dagen, 2009). A report from the UC Berkeley Lawrence Hall of Science (2007) indicates that a decreasing amount of time has been spent on science since the implementation of No Child Left Behind. There should be a balance between "assessment as a tool (guide) and curriculum (curiosity) as a driving force" (Perez & Dagen, 2009, p.38). Classroom teachers must find a balance between age and individual developmentally appropriate practices and the pressure to teach to the test by using drill and repeat procedures.

*Statement of the Problem*

Educators across the nation are facing the issue of trying to find time for teaching science when most of the instructional day is devoted to math and literacy (Vargas, 2008). Classrooms focus on math and reading lessons and activities to equip students to perform well on tests. Because of this, Ediger (2002) suggests that a lack of confidence and competence in teaching elementary science has caused some teachers to feel pressure and anxiety, particularly since the science content area has been added to the subject knowledge assessed in nationwide standardized testing. Until recently, children were tested solely in math and literacy content areas. However, as of 2008, science is now included in the state's assessment status (White House, 2009). The efforts to improve math and literacy scores may have been detrimental to other subject area test scores. Fifth-grade students, the youngest age group in Arkansas identified for target testing in science, may not have acquired the basic science concept skills in early childhood grades to perform well on the mandated standardized test. The Arkansas Department of Education (ADE) implemented Smart Start Legislation in 1999 dictating curriculum changes that reduced or eliminated time spent on science instruction at the elementary level. A lack of science instruction in the early years may affect students' ability to understand and apply more advanced scientific knowledge presented in middle school and beyond (Charlesworth & Lind, 2010). Arkansas Smart Step Legislation, an extension of the elementary focused Smart Start, for grades 5 – 8 was unveiled in 2000. Smart Step continues the math and literacy focus of Smart Start (ADE, 2000).

Teacher-initiated experiences to which young children are exposed are based in part, on the role they can be expected to play in the foundation for children's future learning (Duckworth, 2006; Malcom, 1999; McGinnis & Roberts-Harris, 2009). The teacher's role is to build upon prior knowledge and support children as they move to higher levels of understanding (Charlesworth & Lind, 2010). An understanding of basic concepts strengthens the foundation necessary to support comprehension of more advanced theories and ideas necessary for student success. Barnett and Hustedt (2003) propose that preschool is the most important grade, stating that "Studies have confirmed preschool's positive effects on school readiness and school success" (p. 56). If early childhood teachers are not delivering and implementing effective science instruction in the beginning school years, children may not acquire a basic understanding of general science concepts that would enable them to comprehend more complex information.

*Purpose of the Study*

The purpose of this study is to examine if there is a significant difference in science test scores of schools implementing public policy mandates requiring a teaching focus on math and literacy. What are the effects of public policy mandates concerning student test performance in literacy, math, and science? The Center on Education Policy (2008) reports that time spent on science instruction at the elementary level is significantly less than time devoted to math and literacy; therefore, the changes in science test scores may be significantly different from the changes in reading and math test scores. The specific research questions are:

1. Is there a significant difference between science scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students?

2. Is there a significant difference in math scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students?

3. Is there a significant difference in literacy scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students?

*Significance of the Study*

This study will identify possible significant differences in science, math, and literacy test scores of Arkansas fifth-grade students affected by public policy mandates. Educational decision makers are not necessarily education professionals. Government leaders, business professionals, and public opinion guide changes in education that may be largely influenced by test score competition within the United States and with other countries. Those not trained in child development with an understanding of how children learn may be focused on end goals, like test scores, with little regard for the process in reaching these goals (Warner & Sower, 2005). Educators must be aware of current educational policies and understand the role of the business world in defining education (Perez & Dagen, 2009).

This study may also have an impact on future legislation regarding education practices. The implications for classroom methodology include providing the basic science conceptual knowledge in early childhood grades as a building block for future learning and allowing more time for science instruction. “The key to science literacy is in early childhood programs” (Blake, 2009, p.53). Elementary school students can make considerable progress in developing a more advanced understanding of how science knowledge is constructed (Smith, Maclin, Houghton, & Hennessey, 2000). Through increased awareness of the significance of science to policy makers and the general public, early childhood teachers can take greater advantage of opportunities to identify, encourage, and extend children’s science skills and knowledge (Kilmer & Hofman, 1995). It is recommended that administrators provide more opportunities for teachers to participate in appropriate professional development that increases teacher competency and confidence in science instruction. For example, Conezio and French (2002) suggest that some teachers are uncertain about what to do to introduce more science into their classroom curriculum. A report from the Carmen Group (2007) states that when supported by valid, comprehensive professional development, teachers can successfully enhance the practice of science instruction. This study is significant for determining potential effective practices that prepare teachers and future teachers to be successful in teaching science to young children.

*Limitations of the Study*

There are several limitations to this study:

1. Results and conclusions of this study are limited to fifth- grade students in Arkansas. The findings may not be easily generalized to other educational levels or locations.

2. Because student test scores are taken from the Stanford Standardized Achievement Test and the Arkansas state benchmark test, the findings may not be generalized to other educational standardized or state tests.

3. The research questions may not completely explore all of the important issues affecting science instruction in early childhood grades.

*Assumptions of the Study*

1. It is assumed that science test scores will be lower after implementation of Smart Start Legislation.

2. It is assumed that math and literacy scores will be higher after implementation of Smart Start Legislation.

3. It is assumed that there is a difference in changes between math and literacy scores and science scores pre and post implementation of Smart Start Legislation.

*Overview of the Study*

In this chapter, the researcher stated the problem, the purpose, the significance, the limitations, and the assumptions of the study. Chapter 2 will present a review of six important areas related to science instruction in the early childhood grades. The selected literature includes research in: a) public policy, b) science instruction in early childhood education, c) integrated instruction, d) concept building, e) the role of the teacher in teaching science to young children, and f) professional development for elementary teachers in science instruction.

Chapter 3 will present the methodology for this study. The choice of research tools will also be discussed. The data analysis procedure will be provided. The Statistical Package for the Social Sciences (SPSS) for windows 17.0 will be used to analyze the data to address the research questions presented.

## CHAPTER 2

## LITERATURE REVIEW

The purpose of this study was to examine if there was a significant difference in science test scores of students affected by public policy mandates requiring a teaching focus on math and literacy. This chapter reviews literature related to the topic and includes six sections. Each section describes research in the following areas: a) public policy, b) science instruction in early childhood education, c) integrated instruction, d) concept building, e) the role of the teacher in teaching science to young children, and f) professional development for elementary teachers in science instruction.

### *Public Policy*

Politics and politicians strongly influence educational decisions concerning content matter, teaching strategies and teacher qualifications (Morrison, 2009). Federal and state governments enact legislation that reflects current public opinion about the nation's schools (Warner & Sower, 2005). Education and educational practices are subject to laws and court decisions put in place by the government. Public policy also involves position statements of professional organizations (Morrision, 2009).

In his efforts to improve the nation's education in 2002, President Bush signed into law the No Child Left Behind (NCLB) Act, Public Law 107-110. The American Competitiveness Initiative, resulting from recommendations in an NAS report (2007), inspired NCLB legislation. Rising Above the Gathering Storm: Two Years Later, a report from NAS (2009), indicates that government requested program funding failed to appear. President Obama has plans to reform No Child Left Behind by providing funding that has been lacking (White House, 2009). School and student accountability remains as one of the major focus areas, including a mandate that standardized tests be administered to students at all grade levels (Yellin, Blake, & DeVries, 2004). Literacy and math have been identified as the greatest areas of need, and thereby have become the main focus during the instructional day. States across the nation have implemented public policies that emphasize math and reading, excluding or greatly limiting science instructional time. A report from the Center on Education Policy (2008) indicates that a major portion of the school districts in the United States have been increasing reading and math time at the elementary level while time spent on other subjects has been cut.

During the five years under the Bush education mandate, elementary and middle schools have targeted higher achievement in math and reading with enthusiasm, frequently at the expense of science (deVise, 2007). Vargas (2008) reports, a principal in Virginia told a teacher to discontinue science instruction for the year and focus on math and reading because those are the identified test subjects. High stakes testing and accountability in two specific subject areas has motivated school districts throughout the nation to target math and literacy above all other subjects. The executive director of the California Science Teachers Association has reported district decisions that have made science elective, occasionally integrating science units in other areas of the curriculum, and has allowed that some districts have excluded science completely (Chavez, 2002).

Science instruction time at the elementary level has been pushed aside, or greatly reduced. The Center on Education Policy (2008) has found that 53 % of school districts studied increased instructional time for math and reading while cutting instructional time for science by at least 75 minutes per week. A Maryland State Department of Education report (deVise, 2007) indicates that science was a part of the daily curriculum before the

No Child Left Behind Act, but since the implementation of that law, the 45 to 60 minutes of daily science instruction has been reduced to 30 to 45 minutes with social studies added in that same time allotment. In spite of a reduction in science instruction, early exposure to science is necessary so that students are ready for more complex information as they reach junior high and high school ages. A question raised by one researcher asks how students will understand high school science if it has not been taught before the fifth grade (Asimov, 2007).

Because of the No Child Left Behind policy changes at the national and state levels, math and reading have become the required assessment competency areas. One state, however, had already become familiar with accountability issues and a strong math and literacy focus. Mike Huckabee, former governor of Arkansas, has presented an executive order in 1998, approved by the state legislature in 1999, to implement a new statewide education program. Smart Start targets increased reading and math skills of elementary and school students. Smart Step, a similar program for middle school students, also focuses on math and literacy (ADE, 2000). The Smart Start Initiative advocates training for teachers and principals, uniform student assessment in reading and math, the placement of trained literacy coaches in identified areas, and accountability (ADE, 2002). Yearly state benchmark exams identifying focus areas assess student performance and progress. Benchmark is a term that describes the standard for evaluating a performance (ADE, 2010). Augmented benchmark examinations used in Arkansas include a criterion-referenced component along with norm-referenced testing. The criterion-referenced portion focuses on measuring student performance in areas specifically developed by Arkansas teachers and the Arkansas Department of Education that align with the Arkansas Mathematics and English Language Arts Curriculum Frameworks (ADE, 2010). The norm-referenced section focuses on rank ordering student performance based on national norms that address reading comprehension, language, and math problem solving (ADE, 2010). Science is a recent addition to content areas tested in fifth and seventh grade (ADE, 2010).

The Department of Education for the state of Arkansas has published a Smart Start Newsletter as a platform to share information, highlight early successes and answer questions from the field. One question addresses the time allotment for subjects other than reading and mathematics. The Department suggests, “Teachers might consider integrating the frameworks of other subjects into the teaching of reading, writing and mathematics” (ADE, 1999, p.5). A list of frequently asked questions relating to Smart Start is available on the ADE website. Two questions significant to this study are, “Why does Smart Start focus so heavily on reading and mathematics?” and “How does Smart Start impact middle school and high school students?” (ADE, 2010). The answers provided to these questions by the ADE (2010) imply that proficiency in math and literacy support all other subject areas, and that the state benchmark exams will equip students to be academically successful in middle school and high school. Arkansas teachers have been working within the confines of the Smart Start Program since it became fully functional in the 1999-2000 school year. Classroom teachers have to be committed to finding ways to teach other subject matter when time and focus are devoted to math and literacy.

One elementary school in Northwest Arkansas has generated student interest in learning by adopting two Scottish Terriers as the school mascots, and the dogs became parts of lessons across the curriculum (ADE, 1999). Duncan and Angus, the Terriers, have assisted students' learning by participating in weighing, measuring, and estimation activities, and have provided inspiration for creative writing. At the same time, students have been able to observe characteristics of Scottish Terriers (ADE, 1999). The Smart Start initiative has emphasized reading and math for kindergarten through fourth grade students; however, integrating other subject areas through literacy is one of the nine components in which teachers receive training. Professional development focus includes assisting students in applying strategies learned from literacy instruction to other content areas such as math, science, and social studies (ADE, 2000). Proposed integrated instruction creates a bridge between reading, math, and other subject areas.

Educational public policy mandates, at the local, state, and national levels, have a direct impact on teachers and students (Warner & Sower, 2005). Each program change can affect the way teachers plan, develop, and implement instruction. Increasing student test performance in targeted areas is usually the main objective of legislation concerning education. Regardless of the mandated content goals, integrated instruction provides a way to incorporate all subject areas into the daily curriculum.

*Science Instruction in Early Childhood Education*

The ideal educational setting offers students opportunities to construct knowledge in ways that promote self-direction, critical thinking, experimentation, and social interaction. Most preprimary educational environments, (prekindergarten – kindergarten), provide time for play, interacting with others, and encourage self-direction activities (Chaille & Brittain, 2003). The primary teacher, however, may become so strongly focused on math and literacy assessment that the idea of extra time for science instruction becomes a burden (Vargas, 2008). A study (Harrington, 2005) of teacher attitudes and science indicates that 11% of those surveyed teach science daily, while 50% of those participating reported teaching science only once a week. According to Charlesworth and Lind (2010), inquiry and problem solving should be the focus of science instruction. Inquiry refers to seeking information through questioning or interrogation (Dictionary.com, 2009). Most people think of a body of knowledge when they think of science, but methods and processes as well as ways of knowing and constructing reality are significant and integral parts of science (Lederman et al., 2004).

Science has also been viewed in terms of content encompassing discoveries, research, and technological advancements (Charlesworth & Lind, 2010). Concept memorization required in public schools has reinforced this view. Charlesworth and Lind (2010) have noted the compilation of millions of discoveries, data, and facts over thousands of years, and estimates by some scientists have indicated the amount of scientific information now produced doubles every two to five years. It would be impossible to teach science thoroughly as a body of content knowledge due to the amount of data and materials available.

Providing access to information, exposing learners to high interest topics, and encouraging students to formulate questions and answers promotes a way of thinking and acting resulting in scientific literacy (Duckworth, 2006). Scientific literacy has been defined as a basic knowledge of scientific concepts and processes that enables people to function fully in today’s society (Sherman & Sherman, 2004). Chaille and Britain (2003) have suggested that teachers “embrace characteristics of science and the scientific method that are developmentally appropriate and use the processes of inquiry as the starting point for early childhood science education" (p.14). School reform in almost every discipline promotes the notion that students should be actively engaged in inquiry on a consistent basis (Coulter, 2000).

One Boston Head Start Director uses photography to support children's science inquiry (Hoisington, 2002). By observing and listening, Hoisington discovers how children make connections between previous experiences and current similar experiences. Asking open-ended questions and showing children photographs, specifically of previous block play, causes them to reflect and begin to develop explanations about why towers might stand or fall (Hoisington, 2002). Observation strategies such as these provide a way to implement science concepts in a classroom that allows children time to investigate the learning environment; however, beginning in the first grade, many public school classrooms are required to adhere to a strict daily schedule with limited opportunities for students to investigate areas of interest. To address such limited opportunity for science, the National Science Education Standards provide direction for educators faced with planning and implementing effective teaching practices (Charlesworth & Lind, 2010). Recommended content and methods for teaching science to elementary students include using national standards for appropriate guidelines, engaging learners through interest focused lessons, and focusing on science processes rather than totally on memorization of information.

Knowing how children learn is an essential part of making certain that their needs are met (Warner & Sower, 2005). Young children learn science through investigative play (Wassermann, 2000), and they should be encouraged to inquire, to use higher order thinking skills, observe, compare, imagine, design and invent experiments, and make decisions. Bresnick (2000) suggests that teachers should model the process skills of inquiry by talking through observations, asking questions, and analyzing information so that students know how to go about the process themselves. "Modeling questioning gives the children a sense of what is reasonable to ask, given the constraints of materials available and location in or out of the classroom" (Bresnick, 2000, p. 8). These types of experiences allow scientific thinking, awareness, and understanding to grow. Children learn science more effectively when they inquire through exploration, questioning, and investigation; thus, enabling them to construct their own knowledge (Martin, Sexton, & Franklin, 2005).

Research (Shepardson & Britsch, 2000) suggests that using science journals at the elementary level to record experiences does not necessarily indicate the level of conceptual understanding. In this particular study (Shepardson & Britsch, 2000), researchers purposefully did not give specific instructions for journal writing, which occurred after exploring materials. They discovered that students did not document all of the steps in their explorations, especially as the explorations became more complex. It is noteworthy that teacher questioning was not a part of the exploration process. Klahr and Nigam (2004) have conducted a study that showed direct instruction is more effective than discovery learning. However, the discovery learning approach used in this study did not include teacher interaction. In a paper submitted to the American Association for the Advancement of Science, New (1998) suggests that it is not enough for teachers to prepare the environment and wait for children to take the lead in constructing their own knowledge. Rather, adult interaction can promote student confidence in expressing ideas and experimenting to acquire new knowledge. Teachers, as facilitators, can guide students to instigate conversation that reveals the comprehension level acquired through experimentation (Bresnick, 2000).

The science curriculum should incorporate strategies based on knowledge of how children learn. As proposed by Chaille and Britain (2003), “the curriculum must be responsive to the needs, interests, and capabilities of the particular children being taught” (p. 12). Curriculum decisions in public schools; however, do not rest solely on teachers. Classroom teachers are required to adhere to specific mandates from local, state, and federal agencies regarding content taught and teaching methods. Integrated instruction provides an avenue to incorporate science into daily instruction.

*Integrated Instruction*

The American Heritage Dictionary of the English Language (2005) defines the word “integrate” as bringing all parts together to make a whole, joining or uniting with something else, or making part of a larger unit. The term integration infers that planned lessons and activities in the classroom cover multiple objectives at once (Warner & Sower, 2005). The term, integrated instruction can be interpreted several ways in the field of education. Among related terms are integrated curriculum and interdisciplinary curriculum. Integrated curriculum refers to education implemented in a way that it crosses subject matter boundaries, bringing together different facets of the curriculum in meaningful connections to highlight broader areas of study (Lake, 1994). Interdisciplinary curriculum delineates an approach that provides the necessary patterns and relationships for critical thinking by combining knowledge, skill, and information from varied disciplines (Grady, 1994).

The integrated curriculum approach has varying explanations (Yellin, et. al., 2004). One interpretation describes a way to thread a specific content area into one or more other content areas. Adding a writing component to science investigations would be an example of threading a specific language arts skill into a science content lesson. Another perspective in relation to integrated instruction or integrated curriculum emphasizes combining content areas to reinforce concepts, make new connections between subjects, and create deeper meaning for students. Knowledge construction is an integrative process. Rarely, are knowledge and information used in isolation to answer questions (Biondo, Raphael, & Gavelek, 2000). Lederman et al. (2004) assert that the interdisciplinary approach clearly denotes connections and interaction between different subjects, but remains aware of differences among literature, math, science, and art. Integrated instruction, integrated curriculum, and the interdisciplinary approach may include blending content areas or may incorporate a theme or special topic of interest (Yellin et al., 2004).

To offer such an approach, teachers should discover student interest areas and research appropriate resources that support integrated instruction (Bosse et al., 2009). Providing meaningful topics and experiences can motivate students to pursue knowledge in different ways across the curriculum. One way to include science in daily classroom instruction is to use an integrated approach when planning and preparing lessons and activities. The Secretary of Education, Arne Duncan, has begun speaking of broadening the focus beyond reading and math, stating that “reading and math are important, but so are social studies, science, the arts, and recess” (Associated Press, 2010). In developing science lessons and activities, teachers should consider incorporating reading, writing, and quantification as integral components of effective instruction. (Patrick, Mantzicopoulos, & Samarapungavan, 2009). Rena Dorph, Director of the Center for Research Evaluation and Assessment at the Lawrence Hall of Science at UC Berkley (2007), has expressed concern about the short amount of time allotted for science instruction, pointing out that science is a core subject in public schools. Squeezing or sneaking science into the highly focused math and literacy arena has become commonplace for those teachers and administrators who recognize the importance of providing science instruction to their students.

A principal from San Francisco relates how science merges into the curriculum when teachers shoehorn it in, adding undercover science content into reading and math lessons (Asimov, 2007). In this sense, literacy and math play a large role in the learner's ability to discover and relay information. Students willingly research, document and report when they are engaged in science learning. An integrated curriculum provides opportunities for complex language use and deeper literature investigations than a more disconnected approach to content (Conezio & French, 2002). Science in early childhood classrooms is not a complicated process and is not separate from the normal class routine as young learners frequently ask questions and investigate their environment. Invariably, young children in most environments participate informally in science much of the time. Real life experiences from the world around them cause children to create theories about what makes the world work (Conezio & French, 2002). In this way, children see how science is important to them (Martin et al., 2005).

Research implies that content areas such as science and social studies provide the most logical venue to develop reading, writing, and thinking skills (Yellin et al., 2004). A clear goal for learning is established when students are given a purpose for obtaining information. Children do not learn to read and write in isolation; they learn by reading and writing about a particular topic (Tompkins, 2010). Integrated instruction is most effective when the material from one subject enhances and reinforces another subject area (Yellin et al., 2004). Teachers have the opportunity to engage students in meaningful learning by choosing appropriate topics and teaching skills across the curriculum rather than teaching from time blocks of content focused lessons. The early childhood classroom seems to provide the ideal climate for teaching science through an integrated instructional approach. Children at this age are forming concepts to explain the world around them. Copple and Bredekamp (2006) suggest that "young children, in particular, learn best when the concepts, vocabulary, and skills they encounter are related to something they know and care about, and when the new learnings are themselves interconnected in meaningful, coherent ways" (p.45).

Children will be less likely to struggle with science at an older age when they encounter science concepts at a young and impressionable age. Integrated instruction provides opportunities for young children to experience science as it connects to math, literacy, and other content areas. They may be more likely to develop lifelong interests in science leading them to pursue further studies and careers in the field of science (Howard Hughes Medical Institute, 2002). Children's wonderful ideas do not arise from a void or vacuum, but they are formed on the basis of other knowledge or ideas of children

(Duckworth, 2006). Multifaceted instruction at age appropriate developmental levels enhances basic conceptual understanding.

*Concept Building*

Building on previously constructed knowledge allows students to form a deeper understanding of the concepts presented. Concepts refer to things understood and retained in the mind from reasoning, experience, and imagination (www.Dictionary.com., 2009). Adding layers to prior concepts taught promotes critical thinking and enables learners to more fully comprehend and reflect on the instructional material (Ward, 2001). Students expand their understanding of subject matter and refine their science abilities across many grades (McGinnis & Roberts-Harris, 2009). Charlesworth and Lind (2010) identify the first two years of life as providing the foundation for incorporating future learning into basic concepts that allow children to modify prior knowledge to fit new learning experiences. Early childhood learners are especially curious and receptive to introductory concept lessons that provide the knowledge structure for more advanced instruction. New (1998) notes the significance of the experiences of 3-, 4-, and 5-year-olds as precursors to ensuing learning and academic achievement. Children must have a foundational knowledge of science in order to understand concepts that are more complex in advanced lessons (Charlesworth & Lind, 2010).

Introduction to science concepts at the preschool and elementary levels not only provides the foundation for future learning, but also stimulates the investigative nature of young children. Previously constructed knowledge guides the student in assimilating and accommodating new information (Branscombe, Castle, Dorsey, Surbeck, & Taylor, 2003). Children need to experience science to develop an interest in it. In order to provide such exposure, one first grade teacher from California paid for science materials herself (Chavez, 2002). She implied that students who are not exposed to science before the sixth grade will have little to no interest in it. Abdi (2005) supports introducing science concepts to young learners in ways that are meaningful to them. Intellect cannot evolve without something to contemplate. The more existing knowledge people have, the more fresh ideas result, and the more complex schemes develop. (Duckworth, 2006). In this sense, Dewey's notion of how children learn is helpful (1899/1980). For example, he implies that children do not distinguish experimental science from working in a carpentry shop and do not work to make scientific generalizations; but simply, they like to do things and watch to see what happens. Educators can use this knowledge of how children learn to direct them in ways so that valuable knowledge is imparted through the unintentional investigative efforts of the learners; thus, enriching existing concepts. "It is the nature of science to pose new questions unceasingly and probe further as soon as a certain concept is explained or a problem is solved" (Abdi, 2005, p.12).

Conceptual knowledge is dependent upon individual learners and the connections they make between new and pre-existing information (Abdi, 2005; NSTA, 2008). "The most successful route to mastery in any subject follows a spiral path, in which students regularly revisit and refine their conceptual underpinnings" (McGinnis & Roberts-Harris, 2009, p.63). Young children develop understanding based on personal, meaningful experiences that unify new or more complex ideas with their existing knowledge base. Learning is not a recording process based on inserting data onto a blank tape; rather, it relies on what the individual already knows (NSTA, 2008). In other words, instruction is most beneficial when it is associated with the learner's conceptual framework.

*The Role of the Teacher in Teaching Science to Young Children*

The attitudes children develop toward science are largely dependent upon their classroom teachers (Harrington & Taylor, 2006). Classroom environments, curriculum, teaching methods, and teacher attitudes toward teaching science are all ways through which educators affect how children feel about science. A recent study (Tu & Hsiao, 2008) of preschool teacher-child verbal communication has found that teachers tended to interact with students least often in the science area, as opposed to other learning areas such as blocks-manipulatives or art. It is interesting to note that over half of the twenty head teachers (60%) who participated in the study held a bachelor's degree. Teacher questioning was a key focus for Tu and Hsiao (2008) and they have discovered that study participants used more verbal statements than questioning statements when guiding student learning. However, when provided with a specific science activity, more teachers used open-ended questions during verbal interaction with children. An appropriate classroom environment calls for daily reflection after teacher-student interactions, resulting in more deliberate communication techniques.

Creating a science-supportive classroom environment involves planning and organizing on the part of the teacher. The first step in organizing the classroom is to determine what experiences and activities are necessary to develop concepts (Kieff & Casbergue, 2000). Planning for specific science concepts guides teachers in creating and enhancing learning conditions in the school setting. Teachers should create an atmosphere of anticipation and enthusiasm in the classroom (Abdi, 2005). The classroom atmosphere must be accepting so that children feel free to take risks and express themselves. "Thinking does not thrive in a threatening, intimidating environment where either adult or peer pressure impedes independence" (Adams & Hamm, 1998, p. 29). Hands-on learning may include children conducting experiments with their peers. This type of collaboration necessitates a safe learning environment with adequate space for all students (Martin et al., 2005). Teachers must become knowledgeable about school safety policies, state, and federal regulations regarding school safety in order to provide an appropriate learning environment for children (Koch, 2000).

The science-supportive classroom extends beyond the walls of the school building. Experiences such as nature walks and field trips allow teachers to expand the science-learning environment. Technology also provides a way to broaden the educational setting. Few teacher education programs currently model systemic and sustainable technology integration in science classrooms, and as a result, both pre-service and in-service teachers often hesitate to use such approaches in their instruction (Bhattacharyya & Bhattacharyya, 2009). Technology goes beyond basic e-mail communications and teacher web pages. Computer-based technology enhances the instructional environment by providing access to data and experiences with simulations (Adams & Hamm, 1998). For example, teachers might direct students to an interactive website created by the American Museum of Natural History to learn about paleontology (Sherman & Sherman, 2004). In this way, children can travel to locations they might not be able to visit in person. It is the responsibility of the teacher to research available Internet sites for developmental appropriateness before allowing students access. Developmental appropriateness in this context means the content relates to relevant concepts and is age appropriate for the learner (NAEYC, 2009). The classroom environment provides the atmosphere for learning to take place but the curriculum is the driving force in planning appropriate instructional settings.

In teaching science, teachers are typically required to work within the confines of mandated standards specific to states and recommended standards by national organizations such as the National Science Teachers Association (NSTA) (Warner & Sower, 2005). Administrators or even state and federal policy makers may influence curriculum choices placing teachers in a minor role as decision makers. Classroom teachers may volunteer to serve on curriculum adoption committees, thereby gaining a stronger role in the decision making process. In addition, teachers can assume an active role in selecting appropriate support materials to enhance any given curriculum. Knowledge of prior learning and student interests are key factors in identifying suitable content that engages the learner (Krajcik et al., 2003). Effective science instruction is concerned with making teaching learner-centered (Sherman & Sherman, 2004). The primary objectives in early childhood curriculum are to promote children's development; support children's knowledge, learning, and skills; and to foster children's enthusiasm for learning (Marion, 2010).

Another important role of the teacher is to use appropriate assessments because they are part of one vital component of any effective curriculum. "Assessment can be thought of as any method used to judge or evaluate an outcome or help make a decision" (Krajcik et al., 2003, p.309). Assessment also refers to all the ways education professionals assemble information related to student learning (Sherman & Sherman, 2004). Science assessment refers to ways of accumulating information that is used to ascertain the individual or group performance in a science learning experience (Koch, 2005). Public schools mandate standardized testing that provides one type of student evaluation. Kieff and Casbergue (2000) suggest that tests present limited information concerning children's knowledge, development, and abilities. Teachers must determine what other types of assessments show evidence of student learning. The NSTA (2008) endorses assessments that have real-life relevance and context. Decisions concerning student evaluations should focus on tasks that match the instruction (Koch, 2005). Tests that focus on memorizing facts lead to less cognitive engagement than tests that stress solving real-world issues and that build on prior knowledge (Hilton, 2010). Appropriate assessments allow students to assume an active role in demonstrating their knowledge and capabilities related to the curriculum. This statement also corresponds to teaching methods. Teachers choose a variety of methods and strategies that will meet the needs of diverse learning styles and incorporate an active learning environment. Diverse learning styles refer to various ways in which individuals most effectively incorporate instruction.

To understand diverse learning styles, the Felder-Silverman Learning Style Model formulated in 1988 is useful. It classifies four dimensions in which students prefer one category to another (Felder & Spurlin, 2005). The dimensions identified in this model fit well into science instruction. The four learning style dimensions identified by Felder and Spurlin (2005) consist of sensing, visual, active, and sequential categorizations. These four areas address concrete thinkers, abstract thinkers, learners who prefer visual representations, students who learn by trying things and working in groups, and those who learn in small incremental steps. Educators must consider various learning styles when selecting teaching methods and strategies that are appropriate for multiple learners. Effective teachers use a variety of approaches to implement instruction (Marion, 2010).

Appropriate teaching methods include those that allow students to work with peers and individually, create opportunities to communicate, and provide additional technology, equipment, or manipulative enhancements to instruction (Sherman & Sherman, 2004). Such teaching methods are effective when teachers provide hands-on activities. This type of activity should occupy 60 % of science instruction time for elementary students (Martin et al., 2005). The teacher's role becomes that of a facilitator of learning through motivating students to investigate further to find the answers to their questions. To be effective facilitators of science instruction, teachers must embrace a positive viewpoint about what and how they will teach (Harrington & Taylor, 2006).

Johnson (2004) states that teachers need to have positive attitudes toward new science content and teaching methods in addition to feeling confident in science instruction. Ediger (2002) has related attitudes toward teaching science to teaching competence. Competence refers to being qualified or possessing specific abilities (The American Heritage Dictionary of the English Language, 2005). Koch (2005) suggests previous experiences as a science learner influences the ability to be an effective science teacher. Experiences in school help shape attitudes toward teaching and learning science (Koch, 2005). Teachers should reflect on their own science learning experiences through the years to make realizations and possible adjustments in attitudes toward teaching science.

*Professional Development for Elementary Teachers in Science Instruction*

Professional development must offer the training and support educators need to develop a sense of efficacy in teaching specific content areas. Professional development refers to the advancement of skills or expertise to succeed in a particular profession, especially through continued education (www.Dictionary.com., 2009). Colleges and universities prepare the elementary and secondary teachers who impart lifelong knowledge and attitudes about science and mathematics to their students (NAS, 2007); however, the National Survey of Elementary School Science Teaching reports that relatively few elementary science teachers feel well qualified to teach specific science content areas and almost three-fourths see a pressing need for professional development (Fulp, 2002). Each state requires specific numbers of in-service hours for professional development. Some workshops are mandated by the administration so that teachers are trained in specific topics, but many teachers have the opportunity to choose additional target areas for instruction. Professional development in science instruction should promote changes in attitudes, beliefs, and confidence to change teachers' thinking about teaching science and student learning (Johnson, 2004). Individual school districts have the responsibility to provide teachers appropriate professional development opportunities and the appropriate amount of training time, thereby fostering positive attitudes and a sense of competency.

A recent study (Asimoz, 2007) has reported that 10 times as many elementary teachers claimed they did not feel prepared to teach science than felt unprepared to teach reading or math. The same study revealed that some teachers are overwhelmed with a multitude of materials distributed during in-service training along with rushed explanations on how to use these materials. Lack of preparation in science instruction makes professional development opportunities a critical issue (UC Berkeley, 2007).

In a report concerning an elementary science congressional briefing, the Carmen Group (2007), federal education lobbyists, characterize the present condition of elementary science instruction as weak. Compounding the problem, according to the same report, is the fact that many elementary teachers are extremely uncomfortable and not prepared to teach science. Recommendations to congressional representatives included funding for professional development for teachers. The National Survey of Elementary School Science Teaching found that elementary science teachers reported low levels of participation in science specific professional development (Fulp, 2002).

Teachers need to understand content, methods, and materials themselves to provide effective science instruction in a confident and competent manner. The significance of appropriate science training for teachers has become evident in the professional development offerings some school districts provide for them (Bell, 2002). The Rio Linda Elementary School District in California offered all teachers six hours of training on integrating science instruction throughout the day (Chavez, 2002). Recommended in-service may include workshops, faculty meetings, field trips, independent studies, and further science coursework (Ediger, 2002).

In addition to providing in-service to teachers, higher education institutions have begun to assume responsibility for improving science instruction at the elementary level. Universities in Georgia, Florida, Wisconsin, and Arizona are among those who have offered special teacher training to improve the quality of elementary science instruction (Arizona State University, 2008; Emory University, 2007; National Science Foundation, 2005; University of Wisconsin). Emory University in Georgia established a program that paired college students with elementary teachers (Emory University, 2007). The Elementary Science Education Partners (ESEP) was instantly successful and caused teachers to request additional science instruction training. A program was developed so that ESEP trained teachers could provide science knowledge, inquiry, and leadership training for their peers. In this way, a small group of teachers can affect larger peer groups through sharing information to enhance and support science instruction.

Another in-service program from the Florida Institute of Technology received a grant from the National Science Foundation (2005) to implement the Integrated Science Teaching Enhancement Partnership (InStep). The program mutually benefits participants. InStep Fellows gain valuable teaching, communication, and classroom management skills as well as enhance their impact on k – 12 education. Teachers gain understanding and mastery of science content and concepts as well as increase their confidence with inquiry-based techniques. Likewise, the grant writers for the University of Wisconsin at Milwaukee (2004), report that teachers want to find ways to connect science to what they teach. Balanced Literacy in the Elementary Science Classroom trains teachers to link science instruction to language arts instruction. Monthly meetings provide support for teachers. Participants are encouraged to question science content they do not understand. Program facilitators create a supportive environment that values all opinions and questions (University of Wisconsin, 2004).

Another way universities provide professional development in science instruction is to offer special course work in science content areas. Arizona State University (2008) has written a grant to pilot three online courses with teachers in the Glendale and Isaac Elementary School Districts. The courses focus on life science, physical science, and earth/space science. Other teachers in Arizona are eligible to start taking any or all of the courses as of the spring of 2009. One obstacle in pursuing additional science coursework is the cost for teachers or school districts. Special funding from government or private sources such as the Improving Teacher Quality Grant from the Arizona Board of Regents enables teachers to gain professional knowledge in specific science disciplines that strengthen science instruction in the classroom.

In some cases, the community has also taken a leadership role in providing appropriate professional development for science instruction at the elementary level. A report from The Lawrence Hall of Science at UC Berkeley (2007) shows that external sources help in supporting Bay Elementary School science education. In fact, the report indicates that teachers rate the quality of professional development for science instruction from outside sources higher than sources within the public school system. Some communities may have access to a higher level of community support and involvement in science instruction due to demographics such as population and location, as well as the types of business and industry represented in the area.

Teachers, guided through continual in service training, should increase their knowledge base and skills as professional educators (Ediger, 2002). The responsibility to provide professional development for teacher preparation in science instruction lies with federal, state, and local agencies across the nation. With proper training, teachers can develop a sense of efficacy that translates to more positive attitudes toward science instruction and enhances the quality of elementary science instruction.

In summary, educators must plan science instruction based on their knowledge of how children learn and develop by creating student interest lessons that encourage exploration and inquiry. Although public policy mandates sometimes directly affect or guide curriculum decisions, teachers can still incorporate appropriate science instruction by integrating science into language arts, math, or other content area lessons. The introduction of scientific concepts takes place in the early childhood classroom where students begin to have a fundamental science knowledge foundation for understanding and incorporating information that is more complex. Teachers have the responsibility to choose instructional methods and strategies appropriate to the ages and individual learners in the classroom so that all children can experience a supportive environment that enhances science instruction. In order to ensure that teachers are equipped to make the best decisions in planning, creating, and implementing science instruction, professional development opportunities that create a sense of confidence and competence in teaching science should be available in all school districts.

# CHAPTER 3

# METHODOLOGY

*Research Design*

This study was a retrospective study evaluating whether the implementation of Smart Start Legislation had an impact on SAT and Arkansas state benchmark tests in science, math, and literacy scores for fifth-grade students in Arkansas. It was hypothesized that science scores would show a decrease after legislation is in place, and that math and literacy scores would show an increase. Therefore, to reiterate, the research questions for this study were:

1. Is there a significant difference between science scores pre and post implementation of the Smart Start Legislation for Arkansas fifth grade students?

2. Is there a significant difference in math scores pre and post implementation of the Smart Start Legislation for Arkansas fifth grade students?

3. Is there a significant difference in literacy scores pre and post implementation of the Smart Start Legislation for Arkansas fifth grade students?

*Participants*

Participants were fifth-grade students in Arkansas who took the Standardized Achievement Test (SAT) in 1998, 2003, and 2009, and the Arkansas state benchmark exam in 1998 and 2009. Arkansas state benchmark results for 2003 were not available. In 1998, 29,158 Arkansas fifth-grade students, between the ages of 10 and 12, were given version 9 of the SAT. In 2003, 28,244 fifth-graders took the same test, and in 2009, 34,978 fifth-grade students were given the next version of the Stanford Achievement Test (SAT-10). Because of the way data were collected and archived, there was no demographic breakdown available for the Stanford Achievement Test. However, the Arkansas benchmark scores are segregated by school district. In 1998, 27,553 fifth-grade students were given the Arkansas state benchmark grade equivalency exam in reading and 27, 966 fifth grade students were given the Arkansas state benchmark grade equivalency exam in math. In 2009, 138,577 fifth-grade students were given the Arkansas state benchmark exams in reading and math. The existing data for this study were obtained from the Arkansas State Department of Education. The Institutional Review Board at the University of Memphis granted permission to conduct this study.

*Instruments*

Data from the SAT and Arkansas state benchmark exams for Arkansas fifth-grade students were analyzed in this quantitative study to address the research questions.

*SAT Exam*

The Stanford Achievement Test Series was developed by Harcourt Brace Educational Measurement. The Stanford Achievement Test Series consists of three components: the Stanford Early School Achievement Test (SESAT), the SAT, and the Stanford Test of Academic Skills (TASK). These components assess student achievement in reading, language arts, math, science, and social science for students in kindergarten through 12$^{th}$ grade. Test content varies by subject areas according to grade level.

This study focused, in part, on SAT scores. The SAT consisted of eight levels that measure student achievement from the second half of first grade through the end of ninth grade. The state of Arkansas chose the SAT-8 as the state norm-referenced assessment during the 1995-96 school year. The ninth edition (SAT-9) was used from the 1996-97 school year through the 2002-03 school years. The 10th edition of the test (SAT-10) was used from 2008 to the present. This study examined science test scores from 1998, 2003, and 2009 for Arkansas fifth- grade students.

The ninth edition (SAT-9) consisted of both free and fixed response items, making it both a norm-referenced and criterion-referenced achievement test. The SAT-9 was norm-referenced in the spring and fall of 1995 with a random sampling of students from the 20 % and 30 % of respondent schools, respectively. The SAT-9 was criterion-referenced by a panel of 200 education professionals in 1995. They met together to evaluate how well students of varying performance levels should be expected to perform on the SAT-9. The ninth edition of the Stanford Achievement Test was published in 1996.

Starting with the 10$^{th}$ edition, the SAT is administered under untimed conditions, though recommended times are provided. Harcourt Assessment, now owned by Pearson Education, decided to make the Tenth Edition, SAT an untimed test for several compelling reasons. First of all, 48 of the 50 states require the administration of high-stakes assessments that, rather than testing speediness, allow students to show what they know and can do when measured against criterion-referenced standards. Harcourt conducted its own empirical study that examined times versus untimed testing conditions and found that the amount of time allowed to complete the test had little bearing on student performance. A focus on accommodated, standards-based assessment is supported by the implementation of the No Child Left Behind Act of 2001 (NCLB), the

Individuals with Disabilities Education Act Amendments of 1997 (IDEA), and Title II of the Americans with Disabilities Act of 1990 (ADA).

Harcourt's research design was planned to determine if administering Stanford 10 under both timed and untimed conditions would affect test results differentially. Students taking part in the 2002 standardization of Stanford 10 were tested under untimed conditions. Separate groups of students (approximately 150 classrooms nationwide at each grade level) were tested under timed conditions.

To ensure equivalent samples, students in the timed group were selected to represent the same sampling strata as the larger untimed standardizations group. The variables matched included ability levels, gender, ethnicity, urban versus rural, and disability with and without accommodations, as well as timed versus untimed conditions.

Differences in average raw scores for students tested under timed versus untimed conditions were very small. In the majority of cases, the differences amounted to less than one raw score point.

*Arkansas Benchmark Exams*

The state of Arkansas combined state and national mandated testing requirements in the form of augmented benchmark examinations (ADE, 2010). The exam includes a criterion-referenced component along with norm-referenced testing. The criterion-referenced portion focuses on measuring student performance in areas specifically developed by Arkansas teachers and the Arkansas Department of Education that align with the Arkansas English Language Arts and Mathematics Curriculum Frameworks (ADE, 2010). The norm-referenced section focuses on rank-ordering student performance based on national norms that address reading comprehension, language, and math problem solving (ADE, 2010). Arkansas included science as a test content area in the fifth and seventh grades beginning with the pilot year of spring, 2007, just before the nationally mandated year, 2008, for states to include student performance in science (ADE, 2010).

*Statistical Analysis*

The Statistical Package for the Social Sciences (SPSS) for windows 17.0 was used to analyze the data to address the research questions. Preliminary analyses examined frequencies, distributions histograms, and box-plots to evaluate potential outliers. Two independent t- tests were run to determine any statistically significant differences in the changes of math and literacy scores on the Arkansas augmented benchmark comparing test scores across those students taking the benchmark prior to the implementation of Smart Start Legislation and those students taking the Arkansas augmented benchmark following the implementation of Smart Start Legislation. Effect sizes were also conducted to determine the magnitude of possible differences. The independent variable represented the two time periods that the students took the tests. Two groups are represented: a) Arkansas fifth-grade students taking the test prior to implementation of Smart Start Legislation (1998) and b) Arkansas fifth-grade students taking the test after implementation of Smart Start Legislation (2009). The dependent variables for the two separate t-tests were the state summative math test scores and the state summative literacy test scores for each year represented by the two groups.

# CHAPTER 4

# RESULTS

This study focused on fifth-grade students in Arkansas. In general, fifth-graders are 10 to 11 years of age. There were 317 school districts in Arkansas in 1998; 308 school districts in 2003; and 243 school districts in 2009 (ADE, 2009). Demographic information was not available for 1998. Because science is the central research topic in this study, science data are presented in separate tables for reference. The 2009 demographic data (National Office for Research on Measurement and Evaluation Systems (NORMES), 2009) related to the Arkansas Augmented Science Benchmark Exams are as follows: Total number of African American students tested was 7, 932 (38% Below Basic, 45% Basic, 15% Proficient, 2% Advanced). See Table 1 for full report of scores.

Table 1

*African American Arkansas 5$^{th}$ Grade Science Benchmark Scores*

| Year | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| 2009 | 38 | 45 | 15 | 2 | 7, 932 |

Total number of Hispanic students tested was 3,057 (26% Below Basic, 46% Basic, 25% Proficient, 3% Advanced). See Table 2 for full report of scores.

Table 2

*Hispanic Arkansas 5th Grade Science Benchmark Scores*

| Year | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| 2009 | 26 | 46 | 25 | 3 | 3, 057 |

Total number of Caucasian students tested was 23, 320 (9.75% Below Basic, 33.75% Basic, 44.75% Proficient, 9.75% Advanced). See Table 3 for full report of scores.

Table 3

*Caucasian Arkansas 5th Grade Science Benchmark Scores*

| Year | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| 2009 | 9.75 | 35.75 | 44.75 | 9.75 | 23, 320 |

Total number of economically disadvantaged students tested was 21, 384 (25% Below Basic, 43% Basic, 28% Proficient, 4% Advanced). See Table 4 for full report of scores.

Table 4

*Economically Disadvantaged Arkansas 5th Grade Science Benchmark Scores*

| Year | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| 2009 | 25 | 43 | 28 | 4 | 21, 384 |

Total number of limited English proficient students tested was 2, 348 (31% Below Basic, 47% Basic, 20% Proficient, 2% Advanced). See Table 5 for full report of scores.

Table 5

*Limited English Proficient Arkansas 5$^{th}$ Grade Science Benchmark Scores*

| Year | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| 2009 | 31 | 47 | 20 | 2 | 2, 348 |

Total number of students with disabilities tested was 4, 104 (46% Below Basic, 33% Basic, 13% Proficient, 7% Advanced). See Table 6 for full report of scores.

Table 6

*Students with Disabilities Arkansas 5$^{th}$ Grade Science Benchmark Scores*

| Year | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| 2009 | 46 | 33 | 13 | 7 | 4, 104 |

Total number of female students tested was 17,274 (17.75% Below Basic, 40.75% Basic, 34.75% Proficient, 6.75% Advanced). See Table 7 for full report of scores.

Table 7

*Female Arkansas 5th Grade Science Benchmark Scores*

| Year | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| 2009 | 17.75 | 40.75 | 34.75 | 6.75 | 17, 274 |

The total number of male students tested was 17, 941 (16.75% Below Basic, 36.75% Basic, 37.75% Proficient, 8.75% Advanced). See Table 8 for full report of scores.

Table 8

*Male Arkansas 5th Grade Science Benchmark Scores*

| Year | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| 2009 | 16.75 | 36.75 | 37.75 | 8.75 | 17, 941 |

Identified student population (African American, Hispanic, Caucasian, economically disadvantaged, limited English proficient, students with disabilities, females, and males) science scores presented earlier in separate tables were each added  into one concise format for reference. See Table 9 for full report.

Table 9

*Arkansas 5th Grade Science Benchmark Scores by Student Population*
(2009 scores)

| Student Population | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| African American | 38 | 45 | 15 | 2 | 7, 932 |
| Hispanic | 26 | 46 | 25 | 3 | 3, 057 |
| Caucasian | 9.75 | 35.75 | 44.75 | 9.75 | 23, 320 |
| Economically Disadvantaged | 25 | 43 | 28 | 4 | 21, 384 |
| Limited English Proficient | 31 | 47 | 20 | 2 | 2, 348 |
| Students with Disabilities | 46 | 33 | 13 | 7 | 4, 104 |
| Females | 17.75 | 40.75 | 34.75 | 6.75 | 17, 274 |
| Males | 16.75 | 36.75 | 37.75 | 8.75 | 17, 941 |

Demographic information (NORMES, 2009) for students who took the 2009 math and literacy benchmark exams was also available. The segregated math scores consist of the following: Total number of African-American students tested was 7, 932 (27% Below Basic, 23% Basic, 34% Proficient, 16% Advanced); total number of Hispanic students tested was 3, 027 (16% Below Basic,19% Basic, 39% Proficient, 26% Advanced); total number of Caucasian students tested was 23, 320 (9% Below Basic, 13% Basic, 38% Proficient, 40% Advanced); total number of economically disadvantaged students tested was 21, 348 (18.75% Below Basic, 19.75% Basic, 37.75% Proficient, 23.75%

Advanced); total number of limited English proficient students tested was 2, 309 (19% Below Basic, 21% Basic, 38% Proficient, 22% Advanced); total number of students with disabilities tested was 4, 105(46% Below Basic, 20% Basic, 21% Proficient, 13% Advanced); total number of female students taking the test was 17, 257 (12% Below Basic, 16% Basic, 37% Proficient, 35%Advanced); and the total number of male students tested was 17, 920 (15% Below Basic,16% Basic, 37% Proficient, 32% Advanced). See Table 10 for full report of math scores.

Statistical data for literacy scores are as follows: Total number of African American students tested was 7, 932 (12% Below Basic, 41% Basic, 36% Proficient, 11% Advanced); total number of Hispanic students tested was 3, 020 (10% Below Basic, 33% Basic, 41% Proficient, 16% Advanced); total number of Caucasian students tested was 23, 320 (3.75% Below Basic, 19.75% Basic, 45.75% Proficient, 30. 75% Advanced); total number of economically disadvantaged students tested was 21, 341 (9.75 % Below Basic, 32.75 % Basic, 41.75 % Proficient, 15.75 % Advanced); total number of limited English proficient students tested was 2, 298 (12.75 % Below Basic, 37.75 % Basic, 38.75 % Proficient, 10.75 % Advanced); total number of students with disabilities tested was 4, 105 (34.75 % Below Basic, 38.75 % Basic, 17.75 % Proficient, 8.75 % Advanced); total number of female students tested was 17, 255 (4 % Below Basic, 22 % Basic, 44 % Proficient, 30 % Advanced); and the total number of male students tested was 17, 911 (9 % Below Basic, 29 % Basic, 42 % Proficient, 20 % Advanced). See Table 11 for full report of literacy scores.

Table 10

*Arkansas 5th Grade Math Benchmark Scores by Student Population* (2009 scores)

| Student Population | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| African American | 27 | 23 | 34 | 16 | 7, 932 |
| Hispanic | 16 | 19 | 39 | 26 | 3, 027 |
| Caucasian | 9 | 13 | 38 | 40 | 23, 320 |
| Economically Disadvantaged | 18.75 | 19.75 | 37.75 | 23.75 | 21, 348 |
| Limited English Proficient | 19 | 21 | 38 | 22 | 2, 309 |
| Students with Disabilities | 46 | 20 | 21 | 13 | 4, 105 |
| Females | 12 | 16 | 37 | 35 | 17, 257 |
| Males | 15 | 16 | 37 | 32 | 17, 920 |

Table 11

*Arkansas 5th Grade Literacy Benchmark Scores by Student Population*
(2009 scores)

| Student Population | % Below Basic | % Basic | % Proficient | % Advanced | # Students Tested |
|---|---|---|---|---|---|
| African American | 12 | 41 | 36 | 11 | 7, 932 |
| Hispanic | 10 | 33 | 41 | 16 | 3, 020 |
| Caucasian | 3.75 | 19.75 | 45.75 | 30.75 | 23, 320 |
| Economically Disadvantaged | 9.75 | 32.75 | 41.75 | 15.75 | 21, 341 |
| Limited English Proficient | 12.75 | 37.75 | 38.75 | 10.75 | 2, 298 |
| Students with Disabilities | 34.75 | 38.75 | 17.75 | 8.75 | 4, 105 |
| Female | | 22 | 44 | 30 | 17, 255 |
| Male | 9 | 29 | 2 | 20 | 17, 911 |

Williams (2006) identifies the following general fifth-grade academic expectations in reading, math, and science: reading becomes more complex, requiring full length chapter books and challenging terminology that translates into other subject area textbooks; math requires mastery of all math facts of numbers 1 – 12, understanding of mathematical operations, and beginning geometry; and science focuses on more independent research skills. The Arkansas Department of Education (2009) posted a condensed list of concepts parents can expect fifth-grade students to learn in different subjects, including: solve problems mentally and with a calculator (math); use graphic organizers to analyze, understand text, and organize ideas for writing (language arts); and build simple machines (science). The Arkansas Curriculum Frameworks (ADE, 2010) outline specific student learning expectations for fifth-grade students in all content areas. The State Board of Education requires revision of each of the Arkansas Curriculum Frameworks by a representative committee (inclusive of grade, education experience, gender, ethnicity, geographic region, fiscal status, and school size) of educators every six years (ADE, 2010).

*SAT Scores*

This researcher was able to obtain only overall average SAT scores for the fifth-grade students in Arkansas. Because raw scores were unattainable, the researcher could not calculate variability. Additionally, analyses of variance tests could not be conducted to evaluate whether there were statistical differences between reading, math, and science scores for fifth-graders in Arkansas.

Although statistical differences among the SAT scores could not be tested, the percentile rank mean of reading increased from 1998 (49th percentile) to 2003 ($57^{th}$ percentile), then slightly dropped in 2009 ($53^{rd}$ percentile). The percentile rank mean of math also increased from 1998 ($41^{st}$ percentile) to 2003 ($62^{nd}$ percentile), then remained relatively consistent in 2009 ($60^{th}$ percentile). The percentile rank of science also increased between 1998 ($45^{th}$ percentile) and 2003 ($55^{th}$ percentile), and again slightly increased in 2009 ($57^{th}$ percentile). The mean NCE scores also increased between 1998 and 2003 for all subject areas. See Table 12 for a full report of scores.

Table 12

*SAT Scores of Arkansas Fifth Grade Students*

| Subject | Year | *n* | Mean NCE | Percentile Rank Mean NCE |
|---|---|---|---|---|
| Reading | 1998 | 28, 667 | 49.5 | 49 |
| | 2003 | 27, 969 | 53.5 | 57 |
| | 2009 | 34, 978 | - | 53 |
| Math | 1998 | 29, 154 | 45.5 | 41 |
| | 2003 | 28, 238 | 56.3 | 62 |
| | 2009 | 34, 978 | - | 60 |
| Science | 1998 | 29, 158 | 47.3 | 45 |
| | 2003 | 28, 244 | 52.9 | 55 |
| | 2009 | 34, 978 | - | 57 |

Note. 2009 Mean NCE scores were not available

*Arkansas Benchmark Scores*

In comparing Arkansas state benchmark scores of fifth-grade students, differences between the percent of students who scored below basic in 1998 versus 2009 were assessed for reading and math. Results indicate that there was a statistically significant difference between 1998 reading scores ($M$ = 45.3 [$SD$ = 16.9]) and 2009 reading scores($M$ = 7.2 [$SD$ = 6.3]) ($t$ (482) = 46.3; $p$ = .000). The percent of students who scored below the basic proficiency were significantly higher in 1998 than in 2009. In addition, there was a large effect size ($d$ = 2.10). Math scores also indicated that there was a statistically significant difference between the percent of students who scored below basic proficiency for math scores in 1998 ($M$ = 50.6 [$SD$ = 16.4]) versus 2009 ($M$

= 15.0[*SD* = 16.4]) (*t* (468) = 39.15; *p* = .000). Arkansas state science benchmark scores for 1998 and 2003 were unavailable. The percent of students who scored below basic was statistically significantly higher in 1998 than 2009. Effect size was also large for this difference (*d* = 1.8). See Table 13 for full results.

Table 13

*Arkansas State Benchmark Scores of Fifth Grade Students*

| Subject | Year | *n* | % Below Basic |
|---|---|---|---|
| Reading | 1998 | 27, 553 | 45 |
| | 2003 | - | - |
| | 2009 | 138, 577 | 3.5 |
| Math | 1998 | 27, 966 | 51 |
| | 2003 | - | - |
| | 2009 | 138, 577 | 7.2 |
| Science | 1998 | - | - |
| | 2003 | - | - |
| | 2009 | 138, 577 | 9.1 |

1998 science scores were not available
2003 reading, math, and science scores were not available

# CHAPTER 5

# DISCUSSION

The purpose of this study was to examine if there was a significant difference in science test scores of students affected by public policy mandates requiring a teaching focus on math and literacy. Recall, the specific research questions were as follows: 1) Is there a significant difference between science scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students?; 2) Is there a significant difference in math scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students?; and 3) Is there a significant difference in literacy scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students?

This chapter will address each question in detail.

1. Is there a significant difference between science scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students?

Because of the limited science data available, there were no statistical analyses performed on the differences in Arkansas fifth-grade 1998, 2003, and 2009 test scores (Research question 1). However, based on research from the literature review, Table 12 does indicate increases in percentile rank of fifth-grade science scores between 1998 ($45^{th}$ percentile) and 2003 ($55^{th}$ percentile), then shows another slight increase in 2009 ($57^{th}$ percentile). It is noteworthy to mention that science was only recently added to the nationally-mandated content areas to be tested (ADE, 2009). This may have been a factor in the limited amount of science information available from the state department. It is unfortunate that the Arkansas Department of Education could not provide additional SAT archived data to allow the researcher to perform further statistical tests. Inquiries to obtain data that are a matter of public record became problematic due to a lack of direction in locating the department that could provide requested information. The timeline between the first points of contact and receiving useful information was seven months. The researcher contacted the Arkansas Commissioner of Education and Arkansas state representatives in an attempt to acquire further data needed to complete advanced statistical testing, eventually resulting in a contact person who provided the limited information available. The Arkansas Department of Education (2009) did report that less than half (43%) of fifth-grade students tested in science scored at or above the proficient level on the state benchmark exam.

Several topics examined earlier, such as limited science instruction time (Asimov, 2007; Center on Education Policy, 2008; de Vise, 2007; UC Berkeley Lawrence Hall of Science, 2007), a lack of teacher confidence in teaching science (Carmen Group, 2007; Ediger 2002), or a lack of appropriate professional development (Arizona State University, 2008; Fulp, 2002; Johnson, 2004; NSF, 2005) for teacher training may support Arkansas data (ADE, 2009) that indicate that more than half of Arkansas fifth-grade students scored below the science proficiency level on the state benchmark exam. This information (ADE, 2009) supports the notion that science and all content areas should be included in the required curriculum for public schools and is consistent with Arne Duncan’s call (Associated Press, 2010) for education reform that expands the focus beyond reading and math to consider all subject areas as vital elements of a sound education. The proposed reformed educational public policy would highlight preparing students for college or the job market, rather than concentrating on limited content area proficiency exams as has been done in the past.

Concern about school readiness underscores efforts by local, state, and federal governments to increase investments in charter or private schools to equip the nation's children for college and work (Perez & Dagen, 2009). In Duncan's (Associated Press, 2010) proposed plan, students will be equipped to become productive citizens who will enrich the economy. However, it is important to note that looking at long-range goals does not take away short-term accountability issues for teachers and schools. In his speech (White House, 2009)  announcing the reauthorization of the Elementary and Secondary Education Act (ESEA), Secretary of Education, Arne Duncan, called for accountability tied to growth and gain both in every classroom and in every school. Achievement gaps in underserved student populations must be addressed (White House, 2009). Blake (2009) emphasizes science achievement gaps among different schools and communities within the United States and beyond as a cause for concern about science standards and education.

The 2009 Arkansas Augmented Benchmark science exam results (NORMES) draw attention to the achievement gaps between fifth-grade learners in eight categories. The student groups identified in this data set (NORMES, 2009) are: African American fifth-grade students, Hispanic fifth-grade students, Caucasian fifth-grade students, economically disadvantaged fifth-grade students, limited English proficient fifth-grade students, fifth-grade students with disabilities, female fifth-grade students, and male fifth-grade students. African Americans have the highest percentage (38%, Tables 1 & 9) of students scoring below basic grade level, not including students with disabilities (46%, Tables 6 & 9), though closely followed by limited English proficient students (31%, Tables 5 & 9), while Caucasian students had the lowest percentage (9.75%, Tables 3 & 9) of test scores at the below basic level in science (NORMES, 2009). It is interesting that students with disabilities had a higher percentage (7%, Tables 6 & 9) of science test scores at the advanced level than all other designated student populations with the exception of Caucasians (9.75%, Tables 3 & 9) and males (8.75%, Tables 8 & 9) (NORMES, 2009). This may be attributed to special accommodations made for each student with special needs. Hispanic and African-American populations had equal percentages (2%, Tables 1, 2, & 9) of fifth-grade students who scored above grade level, considered to be advanced (NORMES, 2009). Overall, such specific demographic data are useful in guiding teachers to individualize instruction for all students, especially those learners represented in high percentages of scores below the state proficiency level. Understanding the background knowledge and experience base of each student is a key factor in planning for individual differences.

The performance gap between learners of low-income families and middle-class families needs to be addressed early in children's lives (Copple & Bredekamp, 2006). Early childhood teachers need to pay attention to the social and cultural contexts in which the students live and consider those in creating the learning environment (Copple & Bredekamp, 2006). Methods for obtaining information about each student in a classroom include communicating with the parent or caregiver, former teachers, or questioning the student. Observing each child interact with the environment and peers will also provide the teacher with valuable information. For example, based on an overheard conversation about fear of hurricanes between first-grade students, Diffily

(2003) has developed a plan to implement science project-based learning experiences in which all children chose to participate in different ways. In the process of supporting student interest through reading, writing, and drawing opportunities, the teacher provided books and facilitated discussions, eventually resulting in a student-instigated videotape about hurricanes to share with younger students to alleviate fears (Diffily, 2003). Early childhood classroom teachers are normally responsible for teaching all subject areas, though some schools do departmentalize instruction; therefore, a broad content knowledge base is necessary for teachers to feel confident in educating students in each subject area. Teachers' daily conversations and attitudes displayed toward teaching science in classrooms may influence student attitudes toward science (Harrington & Taylor, 2006).

A lack of teacher confidence in teaching science may have contributed to the low percentage in science test scores on the Arkansas Augmented Benchmark exam (ADE, 2009). Even though some research (ADE, 1999; Chavez, 2002; & Hoisington, 2002) has indicated that a number of teachers make extra efforts to plan and incorporate science into the curriculum, other research (Asimoz, 2007; Carmen Group, 2007; Ediger, 2002; & Tu & Hsiao, 2008) has documented teacher responses revealing feelings of inadequacy and uncertainty in the area of teaching science that may directly impact the instructional methods and strategies used for science instruction, and may even negatively affect the teacher's attitude in relation to science, as a whole. Increased confidence in teaching science is gained through processes such as research into state-determined science grade level student learning expectations, effective planning, including acquiring additional materials and resources well before the day of the science lesson, and preparing the science-supportive learning environment and activities to engage student interest. The classroom teacher supplies relevant background information and supports children as they learn newly introduced science material (Klein et al., 2000). “Effective science teachers are usually those who have built up their science knowledge base and developed a repertoire of current pedagogical techniques” (Adams & Hamm, 1998, p. 44). Elementary school science teachers have articulated a call for help in a variety of ways, specifically in using instructional technology and adding to their own content knowledge base (Fulp, 2002). Appropriate training in science and science instruction supports teachers in strengthening their confidence levels as science educators.

Another possible factor that may have played a role in the low percentage in state-reported (ADE, 2009) science benchmark test scores of Arkansas fifth-grade students is the lack of consistent, appropriate professional development opportunities in the area of science instruction. Studies (Fulp, 2002; Johnson, 2004; & UC Berkeley, 2007) have found that teachers have not been satisfied with the science-specific professional development available to them. Comprehensive or even sufficient training cannot take place in a one or two hour one time session, especially when teachers are bombarded with multiple supplemental materials to use in the classroom (Asimov, 2007). This same research documents the experience of one particular teacher who reported receiving a teachers’ edition of a science workbook containing 1, 199 pages, along with vocabulary and concept cards, flip charts, CDs, DVDs, and four large boxes of materials. In cases such as this, school districts may have unrealistic expectations of teacher preparedness, relying more heavily on adequate materials than adequate professional development. Beginning with the early years in a teacher’s science instruction career, consistent, ongoing professional development should facilitate the advancement of learning from novice to expert (NSTA, 2000).

The increased percentile rank (Table 12) in science scores for Arkansas fifth-grade students on the SAT may be supported by teachers who integrate instruction so that science and other content areas are clearly connected. Elementary school students learn science best when other subject areas are fused into science (NSTA, 2008). In a study (Patrick et al., 2009) conducted over a three-year period, researchers concluded that the integration of reading and writing into science inquiry activities provides an effective and efficient way to teach meaningful science in kindergarten as well as the early grades. When planning and preparing science lessons and experiences, teachers should consciously blend various content areas to enrich instruction. Deliberate teachers make students aware of the crossover between subjects so that children can also comprehend the connection (Protheroe, 2007). For example, a teacher might refer to previous social studies content when teaching about weather changes. The temperature is dependent on location. In this way, students can develop an understanding of learning links across the curriculum. New (1994) reports a strong belief from supporters of integrated curriculum that schools must view education as a process for developing abilities necessary for life, rather than discrete subject matter. Research (Bosse et al., 2009; Grady, 1994; Warner & Sower, 2005; and Yellin et al., 2004) validates the use of integrated lessons as an effective teaching method. The results from the Smart Start Initiative (ADE, 1999) are congruent with the fact that placing an intense, detailed focus on specific subject areas in the early childhood grades leads to improved student achievement in older grades; therefore, a lack of science instruction in the early years may affect a student's ability to comprehend and apply more advanced scientific knowledge introduced in middle school and beyond (Charlesworth & Lind, 2010). Teachers of young children can have a powerful, positive effect on student performance that may extend beyond the early childhood grades.

2. Is there a significant difference in math scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students?

Results (Table 13) indicated that there is a statistically significant difference in math scores pre and post implementation of Smart Legislation for Arkansas fifth-grade students (Research question 2). The percent of students who scored below basic was statistically significantly higher in 1998 than 2009 (Table 13). These differences may be credited to issues previously discussed, such as a strong emphasis on teaching math and literacy (ADE, 2009; Williamson et al., 2005). The ADE (2010) credits the Smart Start math and literacy focus for an increase in student achievement, as well as improved professional development. In a press release (2009), the ADE reports that "for the first time, more than 60% of Arkansas students at each grade level scored at or above proficient on both mathematics and literacy Arkansas Augmented Benchmark Exams" (p.1). In fact, 70% of Arkansas fifth-grade students scored at or above proficiency in math (ADE, 2009). The ADE (1999), through the Smart Start Initiative, authorizes the hiring of additional math coaches to support teachers and students in increasing test performance.

While this is noteworthy information, it is important to examine sub-group performance on the state benchmark test among student populations. The highest percentage (27%, Table 10) of scores (NORMES, 2009) in the below basic category was represented in the African American student population, with the exception of students with disabilities (46%, Table 10). The Caucasian student population had the lowest percentage (9%, Table 10) of scores (NORMES, 2009) at the below basic level. African American students also had the highest percentage (23%, Table 10) of test scores (NORMES, 2009) at the basic proficiency level, followed closely by the limited English proficient student population (21%, Table 10) and students with disabilities (20%, Table 10). Male and female student groups had equal percentage scores (16%, Table 10) in the basic category while the lowest percentage (13%, Table 10) was represented in the Caucasian student population. All identified student population test scores (NORMES, 2009) were within a few percentage points (34% - 39%) of the others at the proficient level, with the exception of students with disabilities (21%, Table 10). The advanced proficiency category was represented at the high end by Caucasians (40%, Table 10), females (35%, Table 10), and males (32%), and at the low end by African Americans (16%, Table 10) and students with disabilities (13%, Table 10). This math demographic information affirms the prior science demographic data that identify African Americans as a student population to target for improved achievement on the Arkansas benchmark exam. Overall, educators should be pleased with the increase in math scores (Table 13) but should also be aware of the importance of individualizing instruction to meet the needs of all learners.

3. Is there a significant difference in literacy scores pre and post implementation of the Smart Start Legislation for Arkansas fifth-grade students?

The results of this study indicated that there was also a statistically significant difference in literacy scores pre and post implementation of the Smart Start

Legislation for Arkansas fifth-grade students (Research question 3). The percents of students who scored below the basic proficiency were significantly higher in 1998 than in 2009. The ADE (1999) implemented the practice of assigning literacy coaches to each school, beginning with five pilot sites in the first full year of the Smart Start Program implementation. Literacy coaches offer on-site support in the form of technical assistance, model lessons, provide on-site consultation, and offer professional development (ADE, 1999). The hiring of the literacy coaches may have contributed to the increase in student scores on the Arkansas benchmark exam.

Student test performance is one of the accountability measures in schools; therefore, the performance of each sub-group of student populations should be explored. The highest percentages of literacy test scores (NORMES, 2009) below the basic proficiency level on the Arkansas Augmented Benchmark exam were represented in the limited English proficiency (12.75%, Table 11) and African American (12%, Table 11) student populations, with the exception of students with disabilities (34.75%, Table 11). Caucasians and females were the student groups with the lowest percentages (Table 11) of below basic test scores (NORMES, 2009) on the literacy benchmark exam with 3.75% and 4%, respectively.

Three student populations had percentage scores (NORMES, 2009) within a four point range of the others at the basic proficiency level. African Americans had the highest percentage (41%, Table 11), students with disabilities had the middle percentage (38.75%, Table 11), and limited English proficient students had the lowest percentage (37.75%, Table 11) of scores (NORMES, 2009) in these three groups. At the proficient level in literacy, Caucasians had the highest percentage (45.75%, Table 11) of scores

(NORMES, 2009), followed by females (44%, Table 11), males (42%, Table 11), economically disadvantaged (41.75%, Table 11), and Hispanics (41%, Table 11). Students with disabilities had the lowest percentage (17.75%, Table 11) of test scores (NORMES, 2009) on the Arkansas literacy benchmark exam. The groups identified as having the highest percentages of test scores (NORMES, 2009) at the advanced level in literacy were Caucasians (30.75%, Table 11) and females (30%, Table 11). The student populations with the lowest percentages of test scores (NORMES,2009) at the advanced level in literacy include students with disabilities (8.75%, Table 11), limited English proficient students (10.75%, Table 11), and African American students (11%, Table 11). Analyzing test data is one way education professionals can assess the effectiveness of instructional methods being used. Although the strong focus on testing is controversial (Hilton, 2010; Kieff & Casbergue, 2000), formative and summative test results can be helpful in identifying student populations who may be underserved. Another action intended to increase student achievement in math and literacy is a yearly conference called Getting Smarter (ADE, 1999). Conference participants have available released items from the primary benchmark exam to examine with same grade level teachers (ADE, 1999).

*Implications for Early Childhood Education*

Based on the results of this study, the following implications for Early Childhood Education regarding math and literacy are presented. Because the detailed science-specific data were unavailable from the Arkansas Department of Education, implications regarding science will be made from the literacy review.

1. Public policy enforcing accountability spurs schools to take action. The federal government has taken an active role in developing laws that influence public school operations since the 1930s (Warner & Sower, 2005). Through the years, programs were funded to provide educational opportunities for children; however, it was not until 1989 that national accountability measures began to be discussed resulting in the establishment of the National Education Goals Panel (NEGP) (Warner & Sower, 2005). President Bill Clinton enacted The Goals 2000: Educate America Act that established national goals and created a National Education Standards and Improvement Council (NESIC) which significantly added legislators to the NEGP (Warner & Sower, 2005). Federal involvement in accountability for public schools continues with NCLB, introduced by President Bush in 2002, and reinforced by President Obama and the current administration (Warner & Sower, 2005). One controversial action resulting from the original NCLB Act was federally mandated standardized testing of preschoolers in Head Start Programs (Perez & Dagen, 2009). There was an outcry from early childhood educators about the lack of appropriateness of this type of testing at the preschool age, which eventually (2007) halted the administration of the test (Perez & Dagen, 2009). Another component of the NCLB Legislation was the creation of No State Left Behind that required states to be held accountable for assessment (Warner & Sower, 2005). The state of Arkansas had already made schools accountable for improved student achievement in the form of legislation implemented in 1999 (ADE, 1999).

In an effort to meet the expectation that all children will meet or exceed grade-level requirements in math and reading by fourth grade, the state of Arkansas instituted a comprehensive plan for early childhood student achievement titled the Smart Start

Initiative (ADE, 1999). Smart Start (ADE, 1999) focuses on strong accountability stressing well defined, high educational standards in math and reading. Standards provide a guide for what children should know and be able to do at different ages and stages (Charlesworth & Lind, 2010). Arkansas state standards align to national professional association standards specific to content area. For example, state math standards align with the standards of the National Council of Teachers of Mathematics, and reading standards align with the International Reading Association standards and support the National Reading Panel indicators of reading success (ADE, 2010). The link to each content area national professional association is provided on the ADE (2010) website. An effective publicity campaign informed Arkansas state school districts, the school administrators, teachers, students, parents, and the public sector of the Smart Start Initiative (ADE, 1999). The ADE (1999) identified coordination between standards, professional development, student assessment, and accountability as crucial elements in the success of Smart Start. The Smart Start Initiative, based on its merits (ADE, 2009), remains a part of the Arkansas school accountability system, and has been expanded in the form of Smart Step, an effort to improve student achievement in math and literacy at the middle school level, grades 5 - 8 (ADE, 2000). These findings of differences in math and literacy scores support the Arkansas Smart Start Initiative. The evidence of the differences in the changes in math and literacy scores supports the Arkansas Smart Start Initiative (ADE. 1999), an early childhood program that mandates a math and literacy focus. The success of this program spurred the expansion of the age or grade focus to middle school, in hopes of similar performance results. Smart Step (ADE, 2000) is the title of the extended Smart Start legislation intended for fifth- through eighth-grades.

This middle school component, introduced in 2000, is actually phase two in the state's effort to increase student achievement in math and literacy. Smart Step offers the same intense training for teachers and administrators, along with additional materials and support to the state's middle school teachers (ADE, 2010).

2. Specific actions implemented by educators scaffold improved student achievement. In order to meet the goals of the Smart Start Initiative in improving student achievement in math and literacy, specific action steps are outlined for clarity in expectations of schools, teachers, students, and administrators. The professional development segment requires either a two- or three-year commitment by the school district, principal, and participating teacher (ADE, 1999). Some of the training topics include implementing a balanced literacy program, integrating instruction in reading, writing, speaking, listening, observing, and thinking, and emphasizing that reading and math are both meaning-making processes (ADE, 1999). Research (Carmen Group, 2007; White House, 2009) identifies teacher participation in quality professional development as a key factor in teacher competency. Scoffolding teachers and students result in gains in student achievement. Results indicate that math and literacy coaches, along with the other support areas outlined above, support teachers and students in attaining the goal of higher percentages of students scoring at the proficient or advanced levels on the state benchmark exam (ADE, 1999). The job duties of math and literacy coaches consist of evaluating school assessment data; providing appropriate direction for aligning local curriculum with Arkansas standards; providing and facilitating professional development needed by schools; and reviewing test scores after professional development implementation (ADE, 1999). Additionally, these coaches can offer assistance to teachers

in the form of model lessons, technical assistance, and on-site consultations (ADE, 1999). Parents are also recognized as an integral part of improving student achievement as the ADE supplies the parent's guide to Arkansas curriculum standards, also referred to as refrigerator curriculum (ADE, 1999). These precise action steps combined scaffold teachers and students as they see gains in student achievement. Results (Table 13) indicate that math and literacy coaches, along with the other support areas outlined above, are successful elements of the Smart Start Initiative.

3. Critical analysis of test data exposes relevant educational issues. Research results from the literature review supply demographic information relating to the test performance of sub-groups of the student population. The sub-groups represented in the data tables are as follows: African American, Hispanic, Caucasian, economically disadvantaged, limited English proficient, students with disabilities, females, and males. Math and literacy data provide critical details about individual student populations. In math , African Americans had the highest percentage (27%) of students scoring below basic grade level, excluding students with disabilities. Caucasians had the highest percentage (40%) of students scoring at the advanced level, though female and male student populations followed closely at 35% and 32%, respectively. Similar results hold true for literacy. African Americans and limited English proficient students had the highest percentages (12%, 12.75%) below basic grade level and Caucasians and females had the highest percentages (30.75%, 30%) at the advanced level. This type of information identifies segments of the student population who may need extra support to show improvement in student achievement.

Koch (2005) provides a list of questions teachers can ask themselves in relation to issues of diversity including: “1) Who are my students?; 2) What are their lives like?; 3) Where do they live?; 4) What interactions with nature are responsible for them?; 5) How do events that shape my students’ lives become opportunities to learn science?; and 6) How are my students’ beliefs about the nature of science informed by their cultural backgrounds and their gender?” (p. 21). Obtaining background knowledge about students can help teachers in developing positive relationships with students and their families. Societal interaction influences learning for children and caregivers who interact with young children in the areas of oral language, reading, and writing are preparing their children for the world of school (Yellin et al., 2004). It is important to understand that the nature of social interaction varies considerably in both the home and the community, particularly relating to socioeconomic level. This fact must be considered by the teacher and certain adjustments must be made (Yellin et al., 2004). When large discrepancies in student performance arise, teachers must differentiate, or teach differently for a specific student or group of students (Koch, 2005). Koch (2005) suggests that teachers who differentiate instruction make the effort to do everything necessary to ensure that struggling and advanced learners, children with varied cultural heritages, and students with different background experiences all grow as much as they possibly can every day throughout the year.

4. Educators develop high expectations for future positive content area test performance. Once schools experience progressive and significant growth in student achievement, they will make every effort to maintain their elevated status or aim even higher. Since results corroborate the practices used in the Smart Start Initiative (ADE,

1999) as statistically significant for early childhood students, expectations of future student test performance within this same program may be high. One example showing how Arkansas had pre-determined expectations for advancing student achievement is the expansion of Smart Start (ADE, 1999) practices into middle school with Smart Step (ADE, 2000). School accountability is not going away. Rather, there are high national and federal expectations for student learning connected to an increased focus on school and teacher accountability, outlined in the reauthorization of the Elementary and Secondary Education Act (White House, 2009).

5. The Arkansas Smart Start Initiative program success may benefit other states. Although this study is state-specific, educators and policy makers in all states and beyond can benefit from the research and implications for early childhood education. A strong foundation of conceptual knowledge and developmentally appropriate experiences relate to the preparation and instruction children receive in early childhood classrooms. The information presented in the research results of the literature review reflects the need to equip young children with a practical and conceptual understanding of science so that they can eventually become scientifically literate and be able to compete in a global market (White House, 2009).

Public policies at the local, state, and national levels guide educational practices and affect students, teachers, and administrators (Warner & Sower, 2005). Early childhood professionals must be advocates for appropriate instructional practices that are effective with young children. Joining professional organizations such as the National Association for the Education of Young Children (NAEYC) provides opportunities for educators to not only become knowledgeable about current legislation, but also affords the option to participate in advocacy interest groups. In this way, early childhood teachers can serve on committees and have a voice in decision-making efforts at the local, state, or national level. Teachers and administrators should be aware of specific government officials and elected representatives who have the power to affect change. Invariably, the people making policy decisions are the furthest from the classroom (Perez & Dagen, 2009) and therefore, may seek expert advice and opinions relating to educational policy legislation and decisions. Teachers with experience in early childhood education can present themselves as experts in their field in several ways, including speaking to parents and community groups about relevant educational information, attending and presenting at educational conferences at the local, state, and national levels, and serving on decision-making committees at the school or district level such as accreditation or curriculum adoption.

6. Improvements in math and literacy scores may translate to science. In reviewing the Smart Start Initiative (ADE, 1999) plan components, the intense focus on math and literacy in daily instructional practices, support from math and literacy coaches, and quality professional development are key factors in making the program successful. If the same intense focus, program components, and resources were applied to the science content area, increased student achievement might be the expected result. There is reason to believe that Arkansas will soon target science in a more direct way because science is now a required content testing area, even though science scores are not used to determine school improvement status. The ADE (2009) notes curricular modifications that should strengthen the teaching of science across grade levels. Although there is certainly a possibility that student performance in science might experience the same positive

growth as math and literacy, the question of sustaining higher student achievement in math and literacy while adding science more fully into the instructional day might become an issue. Arkansas early childhood teachers, like many of their counterparts in other states, are familiar with a daily routine consisting mostly of math and literacy activities that may occasionally integrate other subject areas (Vargas, 2008). However, the spotlight of accountability in a particular content area proves to be a true motivator (ADE, 2009), as seen with the math and literacy focus of Smart Start (ADE, 1999). It will be interesting to see if science receives the same attention and consideration as math and literacy, particularly in the amount of time allotted for supporting activities in each content area and the content area coaches hired as instructional assistants, certified in their respective fields.

7. There is a strong need for science in early childhood classrooms. The research results (Abdi et al., 1998; Arizona State University, 2008; Bell, 2002; Blake, 2009; Bosse, Jacobs, & Anderson, 2009; Carmen Group, 2007; Center on Education Policy, 2008; Chavez, 2002; de Vise, 2007; Howard Hughes Medical Institute, 2002; Kilmer & Hofman, 1995; NSF, 2005; NSTA, 2008; UC Berkeley Lawrence Hall of Science, 2007; University of Wisconsin-Milwaukee, 2004) from the literature review indicate a strong need for science instruction in early childhood classrooms. The 2009 ADE science test score information corroborates the importance of quality science instruction in the public school classroom. Testing provides valuable information that educators can use, along with other evaluation methods, to plan appropriate individualized instruction.

Understanding how children learn is a requirement for all teachers, and is especially significant in the early childhood years (Abdi, 2005; Charlesworth &

Lind, 2010; Duckworth, 2006; New, 1998; & NSTA, 2008). Middle school science teachers expect students to enter their classrooms with an existing conceptual knowledge base in science. Early childhood teachers may feel pressure from upper level teachers as well as from their school administration to account for student performance (Ediger, 2007). Now that math and literacy scores (ADE, 2009) have increased, there is pressure to sustain student performance level, and improve science scores. However, knowledge of how to teach science continues to be a concern for classroom teachers and other education professionals (Carmen Group, 2007; Fulp, 2002). Therefore, an emphasis on thorough specific training in how to teach science in teacher preparation programs and more consistent science-specific professional development opportunities should be made available to early childhood classroom teachers. School districts throughout the United States struggle to find teachers who are qualified to teach science (NAS, 2010). Higher education institutes can positively affect teacher preparation at the undergraduate and graduate levels (Arizona State University, 2008; Emory University, 2007; National Science Foundation, 2005; & University of Wisconsin, 2004), thereby producing science-literate beginning teachers. Partnerships between universities and public schools can have positive outcomes for both parties. The university instructors benefit from participating in current practices in the classroom, thus making them better teachers of the pre-service teachers in their classes. Public school educators gain content knowledge or subject-area specific training that enhances their instructional skills and builds their confidence in relation to teaching competency.

Integrated instruction techniques should be included in the training topics for professional development in teaching science. Knowledge is an integrative progression.

Providing meaningful topics and experiences can inspire young children to pursue knowledge in different ways across the curriculum. Research (Shaffer et al., 2009) suggests that meaningful science encompasses knowledge. For example, a preschool program in Colorado made a conscious decision to focus on the interest of children and build instruction around that interest; in this case, the study of insects (Shaffer et al., 2009). Among the strategies used by teachers to integrate instruction across the curriculum were: interactive conversations between children and children and teachers and children; teachers read books and provided appropriate insect-related literature for students; teachers documented and assessed children using photography for support; and children visually represented insects and what they knew about insects through drawing and using pre-writing skills; therefore, all content areas were a part of the instruction on insects (Shaffer et al., 2009). Science is easily adaptable to the incorporation of other content areas or skills such as reading, writing, or using critical thinking (Conezio & French 2002; Tompkins, 2010; & Yellin et al., 2004). Specific professional development opportunities for early childhood teachers can increase or enhance their confidence levels in regard to science instruction; thereby equipping them to be effective facilitators of science learning for children.

8. Educators, policy makers, parents, and children should develop science awareness. Another implication for the field of early childhood education relates to science awareness of educators, policy makers, parents, and students in a more focused way. A press release from the ADE ( 2009) reported improved state math and literacy scores which highlighted and drew attention to the much lower science scores for the year. One way awareness is developed is through mandated accountability. Public

policies such as Smart Start (ADE, 1999), at the state level, and NCLB (2002), at the national level, dictate accountability measures that create educational-consciousness in both the private and public sectors. “There is a growing awareness that access to thoughtful, engaging experiences in science during the early childhood years can provide both short- and long-term benefits to all children” (Malcolm, 1999, p.2). Another method of calling attention to the need for quality science instruction involves research groups presenting their findings in front of audiences whose members can affect change. For example, the Center on Educational Policy (2008) delivered a report to Congress concerning the state of science in the United States declaring the need for highly-trained teachers. While policy creators and administrators are obvious decision makers, it is also important to make parents and community members aware of the relevance of science in the lives of young children. Research (Lederman et al., 2004) suggests the following reasons why science should be required for all students: 1) Science helps teach critical thinking; 2) Science develops problem-solving skills; 3) Science develops analytical reasoning; 4) Science helps students learn to think; 5) Science develops logical thinking; 6) Science helps students make better decisions; 7) Science is a part of our lives; 8) Science helps explain the world in which we live; and 9) Science is relevant to our everyday lives. Koch (2005) affirms the value of teaching science as it relates to daily life and societal needs in several ways, such as, the realization by educators, leaders of industry, and cultural commentators of the crucial nature of knowing what science is all about, awareness that skills learned using the basic process skills are useful in many fields other than science, and the understanding that teachers can help students improve their abilities to explore a problem from many angles by cultivating scientific attitudes.

When educators, policy makers, parents, students, and communities develop scientific awareness, increased support and participation for science education will result. Through increased awareness of the significance of science to individuals and society, early childhood teachers can take greater advantage of opportunities to identify, encourage, and expand children's science skills and knowledge (Kilmer & Hofman, 1995).

9. Curriculum should support science instruction. An additional implication for early childhood education relates to appropriate curriculum choices that enrich quality instruction in a science-supportive classroom. The curriculum is the plan for equipping children to achieve desired outcomes (Copple & Brededamp, 2006). The perfect science curriculum does not come in a box. Science instruction extends far beyond a textbook or workbook, though it is important to supply children with various types of science books, such as concept-based formats, picture books and informational science literature, as well as hands-on manipulatives. Science in early childhood introduces young children to broad scientific concepts within the big picture (Klein et al., 2000). An understanding of basic concepts reinforces the crucial foundations to support comprehension of more complex ideas and theories necessary for student success. Previously constructed knowledge directs the student in assimilating and accommodating new information (Branscombe et al., 2003). Early childhood students understanding based on personal, meaningful experiences that unify more complicated ideas with their existing knowledge base. Children will be less likely to have difficulty with science at an older age when they are exposed to science concepts at a younger and more impressionable age.

Understanding how children learn is a key factor in assuring that their needs are met (Warner & Sower, 2005). A successful science curriculum starts with knowledge of how children learn; specifically, how they learn science. Charlesworth and Lind (2010) suggest that in order to gain scientific knowledge, students need to interact with materials, collect data, and make some order out of that information. Thinking and wondering are the beginning elements in science investigations. Duckworth (2006) considers having wonderful ideas essential to intelligence. Asking children open-ended questions helps them verbalize their thought processes and guides them in analyzing the information in some way. Teachers who encourage thoughtfulness and contemplation understand that knowledge should be shared or developed; therefore, they arrange science instruction so that children construct concepts, develop their thinking skills, and become more self-reliant (Adams & Hamm, 1998). "As a result, everyone involved becomes an active constructor of knowledge and more capable of making thoughtful decisions in the future" (Adams & Hamm, 1998, p. 29). Science is one curriculum area that is repeatedly downplayed in the early childhood classroom, so by directing attention to questions children ask so naturally in science, teachers can better facilitate their interests and learning (Chaille & Britain, 2003).Young children should be encouraged to inquire, to observe, imagine, compare, to use higher order thinking skills, make decisions, and design and invent experiments (Wassermann, 2000). Charlesworth and Lind (2010) define inquiry for early childhood education as a major focus of science process skill where learners compare their findings. Inquiry lessons promote independent thinking and reasoning. Bresnick (2000) notes the importance of modeling the process skills of inquiry such as observing, questioning, and interpreting at the early childhood level so that children can gain understanding of using inquiry skills. Content learning does not happen by accident in this process, rather, it is dependent on the carefully guided modeling and questioning of the teacher as a facilitator (Bresnick, 2000).

An example affirming that modeling the inquiry process is crucial for student success is presented in the research of Shepardson and Britsch (2000) where they used science journals to evaluate student learning; however, the students who participated in this study were not given instructions or directions as to how to record their observations of what they had learned. One result of this study (Shepardson & Britsch, 2000) was incomplete or inadequate student documentation of learning in science journals that could be used for assessment. Early childhood teachers should always make sure young children have an understanding of learning expectations. One study (Klahr & Nigam, 2004) suggests that direct instruction may be more effective than discovery learning, similar to inquiry learning. The conclusions reached validate what previously mentioned research (Shepardson & Britsch, 2000) discovered in that when students construct knowledge on their own with no guidance, full effective learning will not take place; thereby, Klahr and Nigam (2004) found direct instruction to be more effective. All students, especially young children, need to be given learning expectations with the teacher as a support and guide to reach instructional goals. Inquiry aids in the construction of understanding scientific concepts, learning how to learn, becoming both an independent and lifelong learner, and advancing the development of habits of mind associated with science. (Martin et al., 2005). Children are able to inquire when given hands-on learning experiences, appropriate materials to investigate, puzzling circumstances or problems for motivation, enough freedom to exchange ideas and make personal learning discoveries (Martin et al., 2005). Abdi (2005) suggests that teachers present a discrepant event, an unexpected incident that should contrast with students' prior thinking, to motivate students in using investigative reasoning to find solutions.

Teachers demonstrating an effective science curriculum will employ interactive communication, the use of appropriate literature, will prepare a science-supportive indoor classroom setting, and will make use of the outdoors as an additional science-supportive environment. Creating a science-supportive learning environment involves planning and organizing on the part of the early childhood teacher. The mood or feeling in the classroom must be accepting so that students feel free to express themselves (Abdi, 2005). Assessment is also an essential element in a science-supportive curriculum. Though each school district administers specific tests, early childhood teachers must develop and use other methods for evaluating student performance. According to Kieff and Casbergue (2000), tests provide limited information about children's development, knowledge, and abilities. Assessment is the process of looking at children's progress toward desired outcomes (Copple & Bredekamp, 2006). Science assessment refers to a means of accruing information used to ascertain the individual or group performance in a science learning experience (Koch, 2005). Effective assessments have real-world context and relevance (NSTA, 2008), and allow children to assume an active role in demonstrating their knowledge and abilities related to the curriculum. Sherman and Sherman (2004) assert that appropriate teaching strategies include those that permit children to work with peers and individually, create opportunities to communicate, and provide additional technology, equipment, or enhancements to instruction. Activities such as these should absorb 60% of the time spent on science instruction for early childhood students (Martin et al., 2005). Following this time allotment guide for teaching science will ensure that children are active learners participating interactively in an effective science curriculum.

10. Early childhood student learning may affect student learning in upper grades. Children begin to construct a conceptual knowledge base during the early childhood years. The first two years of life provide a foundation for incorporating future learning into basic concepts that enable children to modify prior knowledge to fit new learning experiences (Charlesworth & Lind, 2010). Introduction to science concepts in early childhood classrooms not only provides the foundation for future learning, but also stimulates the investigative nature of young children. Prior knowledge aids the students in assimilating and accommodating new information (Branscombe et al., 2003).

Young children develop understanding established by personal, meaningful experiences that unify new or more complex ideas with their existing knowledge base. With this in mind, early childhood educators must see themselves as among the first facilitators of learning in the continuing educational process. Early childhood programs provide the basis for science literacy (Blake, 2009). Quality science instruction at the elementary level is necessary for children to understand new science concepts and content as they move on the middle school and high school (Charlesworth & Lind, 2010). Although the scores for science in Arkansas could not be attained, The results from the Smart Start Initiative (ADE, 1999) indicate that placing an intense, detailed focus on specific subject areas in the early childhood grades leads to improved student achievement in older grades; therefore, a lack of science instruction in the early years may affect a student's ability to comprehend and apply more advanced scientific knowledge introduced in middle school and beyond (Charlesworth & Lind, 2010). If teachers are not delivering and implementing effective science instruction during the early childhood years, children may not acquire the basic understanding of general science concepts they need in order to comprehend more complex information. Research (Barnett & Hustedt, 2003) confirms that preschool can have positive effects on school readiness and success. Continued funding of early childhood programs is a critical part of providing for the educational needs of young children. Through increased awareness of the significance of science to policy makers and the general public, early childhood teachers can promote an educational environment that prepares students for future learning. Teachers of young children can take advantage of opportunities to identify, encourage, and extend their students' science skills and knowledge to prepare them to meet teacher expectations at the middle school and high school levels.

*Recommendations for Further Research*

Additional research recommendations include investigating future test data, conducting action research with early childhood teachers, studying young children and science activities, tracking student achievement in science by demographics, and comparing science experiences and student achievement in science of same age level students in other countries. The following recommendations originate from the experiences of this researcher in conducting this quantitative study.

1. Conduct studies on student achievement in science on state and national tests. Science, a recent testing focus area, should be supported in the future with more intentional science instruction in the early childhood classrooms.

2. Specific research on student achievement in science for fifth-grade students in Arkansas is recommended. The ADE (2009) has indicated that science would be a larger consideration in the instructional day due to the accountability focus. The ADE science data collection should provide more detailed information for this type of research. With more detailed data, more complex analyses may be performed.

3. A study engaging early childhood teachers as participants can examine methods of teaching science to young children. Teacher discussion and observation can provide information on methods used. The researcher can create an assessment to evaluate the effectiveness of each method or even test new methods for teaching science.

4. Implement research to observe and to analyze young children engaged in science activities in order to support learning and development. The researcher might conduct studies on existing activities or might introduce new science activities to the whole group or a small group. Data about individual activities can be recorded. The study may involve creating some type of assessment if new activities are introduced.

5. Conduct research to track student achievement in science by demographics. The researcher might use existing data at the state or national level or conduct studies using criterion-referenced data. This type of study might involve examining or introducing new activities.

6. Examine further studies of the comfort level of early childhood teachers in teaching science. Teacher confidence in science content knowledge may influence teacher efficacy.

7. Future studies should be more inclusive, where results are not limited to one state.

8. Compare student achievement in science between children of the same age or grade level and their counterparts in other globally competitive countries.

9. Investigate cross-cultural methods for teaching science to young children in countries highly ranked in student achievement in science.

Personal Reflection

The journey from the beginning to the end of my doctoral program has been filled with highs, lows, roadblocks, and breakthroughs, both in actual required course assignments and program specifications, and in my personal life. As a public school kindergarten teacher and mother of two young sons, I had no thoughts of pursuing a doctoral degree. After 12 years of teaching, I was ready for a change and Arkansas State University, located in my hometown, offered me the change that instigated my journey to obtain a Doctor of Education Degree. I started teaching for them, first as an adjunct, then as a full time instructor. In order to maintain my full time status, it became necessary to obtain a doctoral degree. Therefore, I began searching for a university that offered the type of degree I was seeking and that provided a course schedule that would allow me to work full time. My first point of contact at the University of Memphis was Dr. Satomi I. Taylor, who was the department chair at the time. I had no prior knowledge of anyone at the university, so I relied upon the U of M website to guide me, resulting in an e-mail to Dr. Taylor. From the first day in 2004 to the final day in 2010, Dr. Taylor has provided encouragement, guidance, and empathy as I have worked through my program of study and difficult circumstances.

I began my coursework in 2004 and completed it in 2006. Fortunately, a friend and co-worker enrolled in the U of M doctoral program with me, so I had a travel partner to make the trip for evening classes two nights a week, daily summer school, and someone to share a hotel room for weekend seminar classes during the two-year period. There was only one course in my program of study offered partially online at that time. After I passed my comprehensive examinations in the spring of 2006, I immediately enrolled for dissertation hours and obtained IRB permission to begin my study. I was so excited to complete my degree! Little did I know that my life was going to drastically change. On August 11, 2006, my 19-year-old son was struck by lightning and killed. Needless to say, this affected me so profoundly that my timeline to complete my dissertation was significantly altered. My faith provided and still provides the incentive to move forward, beyond current circumstances. Another factor that influenced my timeline was our relocation to another city in Arkansas, where we started a business. I had to apply to be re-admitted once I decided that I could focus on dissertation work again. The Graduate Office worked with me to make sure I followed the proper steps.

I had planned to conduct a combination of qualitative and quantitative research, but decided that a quantitative study would be more time-effective. My data were a matter of public record housed at the Arkansas Department of Education; however, obtaining the data turned into lesson of perseverance. Through repeated attempts to get information from various departments, I finally found someone who could help me. This process was extremely frustrating, especially when I discovered that the state department could not locate requested test score information! Thankfully, my statistics professor, Dr. Shelly Stockton, offered sage advice and support so that I could perform the study. My actual timeline to complete my program of study from beginning to end extends from 2004 to 2010.

I am currently an assistant professor in curriculum and instruction at Henderson State University in Arkadelphia, Arkansas. The specific courses I teach are within the Early Childhood Program. I can say, without a doubt, that my experiences in taking courses and working on my dissertation have made me a better teacher. The instructors I had motivated me to be consistently reflective and to thoroughly examine research, as well as my own thoughts and ideas. Because of this, my expectations are higher for myself and my students, who are pre-service teachers.

Advice I would give anyone pursuing a doctoral degree include: maintain a support team, whether it consists of family, friends, or both; connect with an advisor who acts as an encouraging mentor (like Dr. Taylor!); stay informed about program requirements; develop a positive rapport with instructors who may serve on dissertation committees; determine accessibility of the data needed to complete the study in advance; and persevere, persevere, persevere! Many people have asked me over the last several years if I am “Dr.” yet. That question makes me want to pull my hair out! I relate it to when I was pregnant and people continuously asked when I would have the baby. Completing a dissertation requires commitment and a strong focus on parts to whole. I have seen my “parts” come together as a “whole” and I am very proud of the final product!

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